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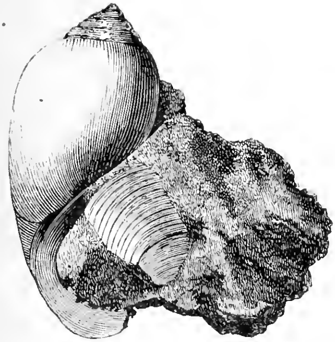

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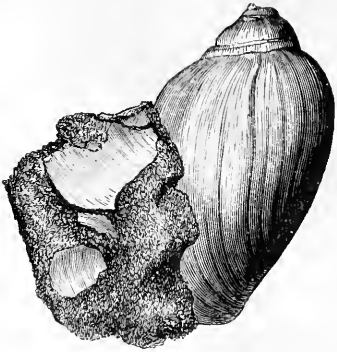

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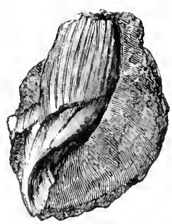

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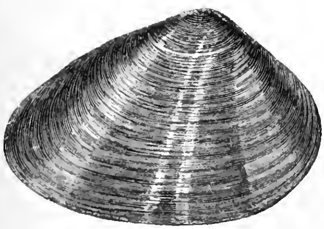

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PITHARELLA RICKMANI AND CYRENA DULWICHIENSIS.

(Figs. 1 to 3.) (Figs. 4 and 5.)

In the Collection of F. E. Edwards, Esq., F.G.S.

S. J. Mackie, del.

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THE GEOLOGIST;

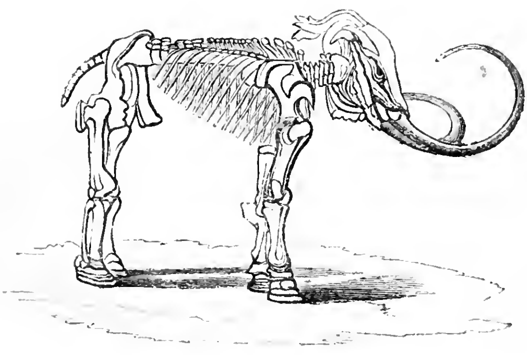
A POPULAR ILLUSTRATED

MONTHLY MAGAZINE

OF

GEOLOGY.

EDITED BY S. J. MACKIE, F.G.S., F.S.A.



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PREFACE.

As the snowball gathers weight and size in its rolling, so from the first hour I took charge of The "GEOLOGIST" has it incessantly gathered strength in rolling on, until now it stands, if my information be correct, unrivalled in circulation by any British scientific periodical.

I may be permitted some gratification in this result; and this feeling of pride is enhanced by the knowledge that of two previous attempts by others, one failed to accomplish a seventh number, and the other died at the third, although aided by liberal donations of plates and absolute gifts of money.

The unvaried success, continued uninterruptedly to the present hour, augurs well and, to me, hopefully for the future. I trust my readers will support me by endeavouring to extend still more the circulation of the magazine, and thus to supply the necessary "sinews of war" for its further improvement and enlargement.

My fire burns brightly in the grate; the wind gently whistles at my window; the moon tips the ripples of the pond in my garden with pearls of silvery light; the air is just keen. By-and-bye the bright coals will burn blue between the flaring flames of the Yule log; old Boreas will lustily howl his hurricane; the pale moon will wanly illuminate the smooth-surfaced ice: and skaters will blow

their tingling fingers through their woollen mits. Christmas again is coming; and a merry, hearty, jovial, happy time may it be to all and every of my friends and readers—aye, and to my enemies, too, if I have any;—on that one day, at least, God bless them.

My thanks are again due to my good and sincere friend, Thos. Davidson, Esq., for his excellent contributions on the Scottish Brachiopoda, and to my other excellent friends, H. C. Salmon, Esq., F. E. Edwards, Esq., Dr. Gibb, T. Rupert Jones, Esq, G. V. Du Noyer, Esq., C. Moore, Esq., Major Austin, and my other contributors.

I ought also to return my best thanks to my very numerous kind querists for the many gratifications they have given me in the pleasures I have had in replying to their interesting questions. Nothing seems to make my editorial labours so light as these kindly communications; they seem a homely family link between us that binds us together in the great brotherhood of geologists.

On the 1st of January, 1861, I shall again hoist the old colours, when our ship will appear with fresh decorations, handsome to look at, and in thorough repair. Some new and agreeable passengers will be on board amongst the old sailors, and we shall start vigorously on our fourth voyage.

S. J. MACKIE.

December, 1860.

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THE GEOLOGIST.

JANUARY, 1860.

THE COMMON FOSSILS OF THE BRITISH ROCKS.

BY S. J. MACKIE, F.G.S., F.S.A.

(*Continued from vol.* ii., *page* 427.)

CHAP. 7.—*First Traces of the Succession of Life.—The Lower Silurian Rocks.*

OBSCURE as are the animal remains of these old Lingula-flags, the traces of vegetation are yet more difficult to make out and to describe. Easier, too, are they to describe than to figure; for, mere shallow impressions and stains as they are upon the cleaved rock, it is easier to see their remote resemblances to some known forms than to convey an idea of them by the finest lines that the graver will cut upon the wood. And then how unsatisfactory to spend days in elaborating the representation of a mere fragment, the very characters of which we are in doubt about.

We shall shortly present our readers, however, with figures of the most illustrative specimens we can obtain of those sea-weeds of the primeval shores, the *Cruziana semiplicata*, the *Chondrites* (?) *acutangulus*, and *Chondrites* (?) *informis*.

In North Wales, near Tremadoc, an upper portion of the Lingula-flags, consisting of dark grey or blackish schists with thin layers of grit, has been made out by Mr. Salter. This upper zone, in addition to the *Lingula Davisii* and *Agnostus pisiformis*, presents us with two other forms of trilobites, *Conocephalus invitus* (Salter), and *Elipsocephalus* (?) *depressus* (Salter), with a bryozoan (plate ii.), the oldest of the group yet known, supposed to be allied to Fenestella, and

intermediate between the Fenestellida and the Graptolites, and named *Dictyonema* (*Graptopora*) *socialis* by Mr. Salter; also a small *Orthis* and a Scandinavian trilobite, *Olenus alatus* of Beck. The fossil Dictyonemæ completely cover the surface of a black slaty layer at that place; and near Maentwrog and Ffestiniog the same bed has been observed overlying the lighter coloured and more sandy mass of the Lingula-flags proper, and apparently forming a conformable bed of passage into the lowermost portion of the Llandeilo group.

Such then, and so scanty, are all the trophies as yet obtained from these ancient silurian rocks—the Lingula-flags. Let us cast our eyes over the equivalent rocks in other lands. In North America vast is the development of the Potsdam sandstones which represents them, but in these the fossils are like, and few. In Bohemia, Scandinavia, France, Georgia, and other places it is the same.

From Newfoundland, during the past year, we have indeed been presented with a giant trilobite nine inches and a-half across, and named by Mr. Salter *Paradoxides Bennettii*. But this difference only of size from the other species of the same genus in these rocks, confirms rather than depreciates the conclusion which Sir Roderick Murchison has come to of the paucity of life-forms at this early stage of the elaboration of the stratified crust of our planet.

Whether the geographical distribution of particular species in particular regions at that remote era will be established as a fact or not, it is certain that the range of organic forms was at its maximum then; while the similarity of the forms presented in regions far remote and apart, seems certainly to indicate more equitable conditions of climatal relations. This is what we should expect from the general low oosy character of those tide-washed lands, and the still warm and reeking atmosphere in which the whole globe was probably enveloped.

Let us pause for one moment on the strange scene. That great expanse of sea, those wide, flat, muddy shores, over which the unchecked tides ran rippling with rapid speed in a thin sheet, waving into life the silken weeds, and ebbed as quickly, triturating in their unctuous passage the fine material particles finer and finer, leaving tiny pools innumerable, shallow lagoons, and mimic lakes for Hymenocarides and Trilobites to sport and grovel in. How glori-

ously the pale "queen of night" must have shed her rays along that glistening tract, and how fair and white the long curling shore-waves must have looked, as they caught with their rolling crests her silvery beams, and perchance reddened in the glare of some raging volcano. Over the endless ocean the glittering flood of light ranged away, until far, far off in the grey and misty horizon, it mounted to the clouds, and seemed to mingle earth with heaven. How beautiful must have been the moon's light then, when only the trilobites turned their hundred-lensed eyes towards her, and skipping Hymenocarides in their sportive progress, spattered out of the shadowy pools sparks and flashes of bright light. What a world of silence, unbroken save by the rushing of the wind, or the murmurs of the sea. No beast upon that oosy land, where nor grass nor herbage grew. No birds nor insects in that dewy air; nor waves nor ripples landed the glittering fish upon those slimy shores; the wide expanse of waters was untenanted by the scaly tribe, and the sluggish shell-fish, worms, and three-lobed crabs, and their shrimp-like congeners, were the sole tenants of the earth.

(To be continued.)

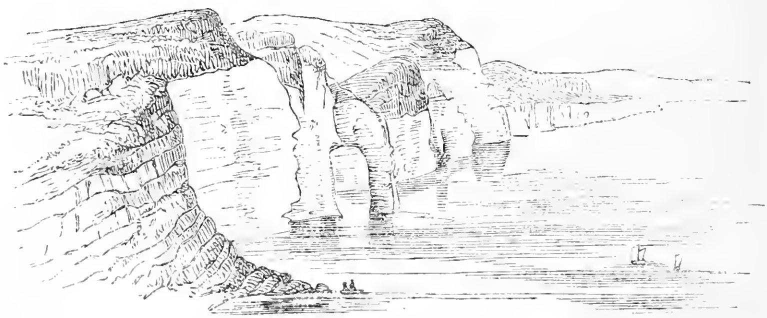
NOTES ON THE STRATIGRAPHICAL POSITION OF THE GIANT'S CAUSEWAY, AND THE STRUCTURE OF THE BASALTIC CLIFFS IMMEDIATELY ADJOINING IT.

By Geo. V. Du Noyer, M.R.I.A., Senior Geologist of the Geological Survey of Ireland.

During a visit to the Giant's Causeway in the month of September, 1857, I made a few notes and sketches on the spot, having reference more particularly to the determinating of the stratigraphical position of the Causeway itself, and to get if possible a clear idea of the structure of the exposed cliff-sections of the basalts in the immediate neighbourhood. On comparing my observations with an account of the causeway and the adjoining coast given by the Rev. John Dubourdieu in his statistical survey of the county of Antrim in 1812, I was struck with the discrepancies which exist between them, the

author's idea being that the bed of Basalt forming the Causeway extended eastward to Portmoon, a distance of two-miles (page 46), and that the whole of the strata are *parallel* to each other. These suppositions are, as far as I am aware of, adopted by all subsequent writers on the Causeway; and as they are errors, a transcript of my notes may not be unacceptable to the readers of the "GEOLOGIST;" they tend at least to illustrate more fully the structure of the Basaltic deposits to which I allude, and are a few additional facts added to our present information on this interesting subject.

Proceeding to the Causeway from Portrush, when we arrrive at Dunluce Castle the views of the coast are remarkably striking and instructive. That to the west, from a window in Dunluce Castle (Fig. 1) shows the junction of the Basalt and Chalk

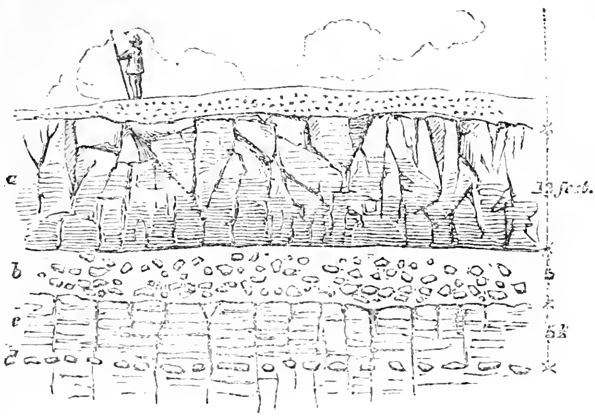


Lign. 1.—View looking west, from a window in Dunluce Castle. Chalk Cliffs capped by Basalt.

most admirably. The Basalt, which for the height of some hundreds of feet above the Chalk is quite amorphous, is seen capping all the low chalk promontaries along the coast. Between Portrush strand and the stream adjoining Dunluce Castle on the west, the absolute junction of the two rocks can be closely studied in many places on the road which passes over the cliffs alluded to, the surface of the chalk on which the basalt rests being very uneven, and in some places excavated into wide and deep gullies like the transverse sections of river-courses; at others it presents bluffs or possibly headlands against which the basalt has flowed, and which it eventually completely overlays. In this view the cliff close to the spectator is

formed of bedded basalt which rises from the sea, the adjoining headland beyond it being chalk; thus we have an example of the latter kind of junction between these two rocks, as the supposition of their being brought together by a fault is not tenable.

To make this paper more complete I have introduced the accompanying sketch of the junction of the basalt and chalk on the Portrush shore, as showing that fact more in detail.



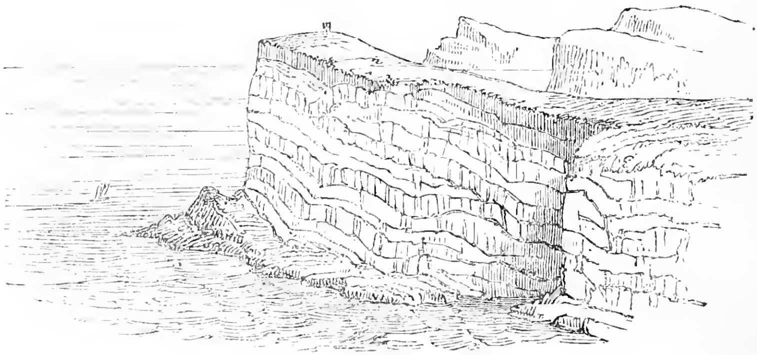
Lign. 2.—Junction of Basalt and Chalk, Shore of Portrush, Co. Derry.

a. Amorphous basalt, becoming so decomposed in its lower portion as to resemble dark brown earthy shale.

b. A layer of drift-flints, water-worn, enclosed in what is now hardened, or baked chalk-mud—the flints being most numerous at the bottom of the deposit. This rests on the erroded surface of the chalk proper (*c*), showing that before the deposition of the basalt, that rock had been subjected to forces of sub-marine denudation, and that the basalt flowed over it while so submerged. The chalk, though not distinctly bedded, exhibits numerous lines of lamination, which are parallel to the direction of the layers of flint (*d*). Numerous joints rather wide apart traverse the chalk layers at their upper part, vertically.

The view (fig. 3) also from Dunluce Castle is in the opposite direction to the former, or looking east towards the Causeway-

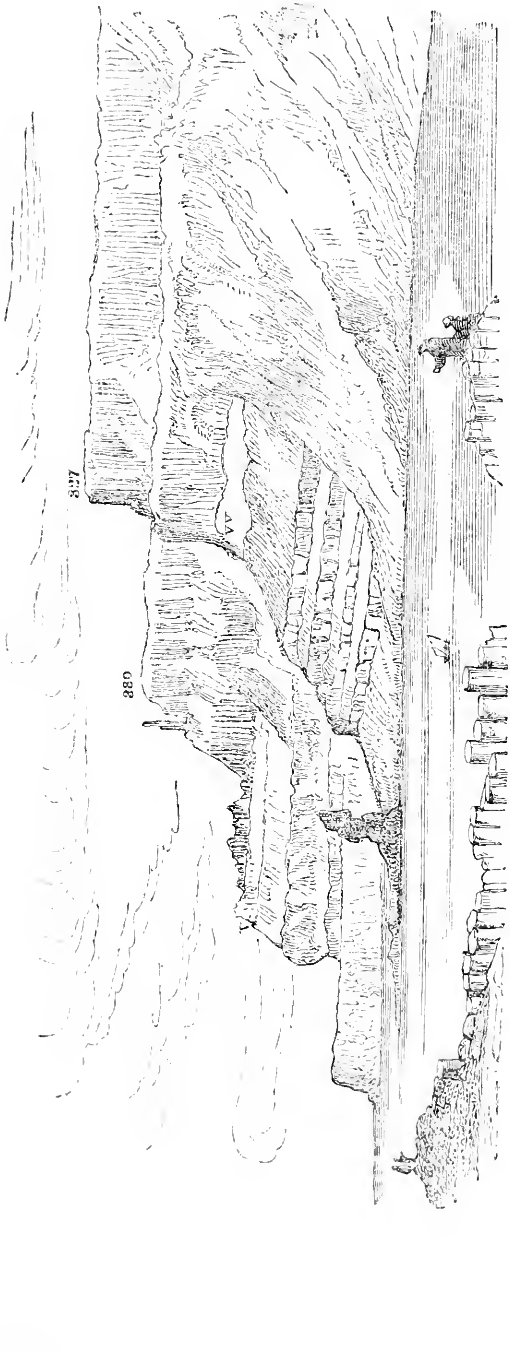
headlands; the low promontary in the foreground is formed entirely of bedded basalt apparently of different degrees of hardness, and is exceedingly interesting, as affording an insight into the true manner in which basaltic flows of unequal compactness are deposited, a single bed of harder basalt being observed to branch



Lign. 3.—View looking east from a window in Dunluce Castle, the Causeway-headlands in the distance. Irregularly deposited Basalt.

off so as to form two beds, each equal in thickness to the first; while in another part of the cliff two beds join into one bed, which then equals their united bulk. These are facts that we must bear in mind when examining and describing the Causeway and the adjoining cliffs.

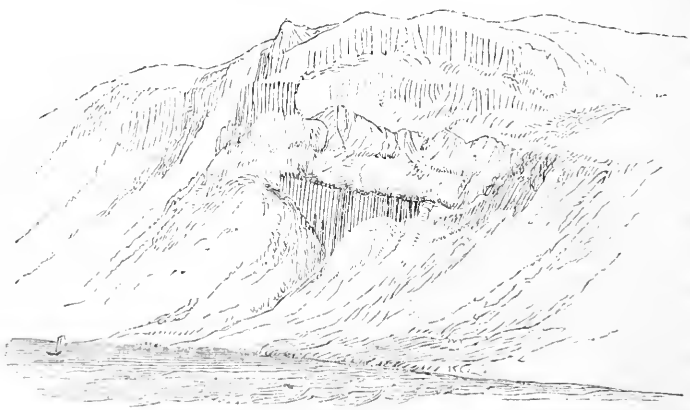
To the spectator who stands on that bed of columnar basalt called "The Giant's Causeway" the view presented on the north-east, across Portnoffer Bay, embraces the profile of the Chimney-headland, half a mile distant and three hundred and eighty feet in elevation, as well as that of the nearer and less lofty projection of the coast east of Portnoffer, three hundred and twenty-seven feet above the sea. Adjoining this is the group of columns called "The Organ," part of which is shown at the extreme right of the view (fig. 4); the distance between the "Chimney"-head and Portnoffer-point is only two hundred and fifty yards.



Lign. 1.—View from the Giant's Causeway, the Chimney-headland bearing N.E., and distant half a mile.
v vv, Ochre beds. x, Part of the Organ-columns.

The section at the Chimney-headland is as follows: commencing at the top, two thick beds of columnar basalt, closely resembling each other in appearance, a few columns of the top one being left standing apart from the main mass at the edge of the cliff, thus suggesting the idea of the "chimney;" the floor of the upper bed is remarkably level. These columnar basalts rest on what is known as the great ochre bed—a well marked feature in the section. Below this ochre layer the remainder of the cliff consists of possibly four deposits of amorphous basalt, each separated from the other by a thin layer of ochre.

In the lesser headland, east of Portnoffer Bay, the section is very similar to that just described; the two upper columnar beds are again recognized, and together rest on the ochre bed, which here, however, has become considerably thinner, and, owing to a steady dip of about five degrees to the west in all the beds at that side of the Chimney-head, it is now much nearer to the sea than before; this may be the result of a slight upheaval *en masse* of the beds at the Chimney-headland.



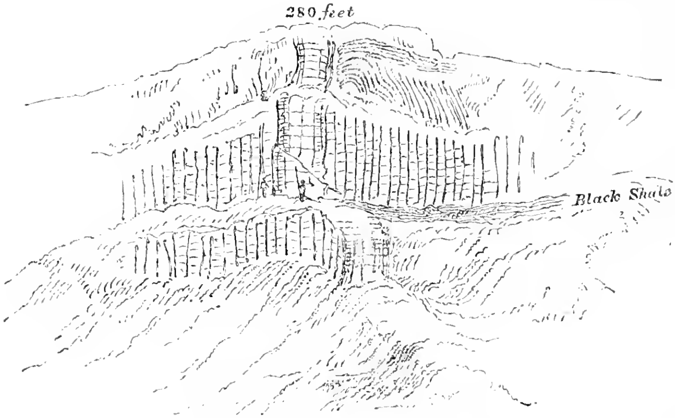
Lign. 5.—The "Organ."

If we attempt to follow the great ochre bed towards the Causeway, or in its western extension, it appears to thin out, and to be easily concealed by the debris from the cliffs above, and eventually a very marked change is observed in the superimposed

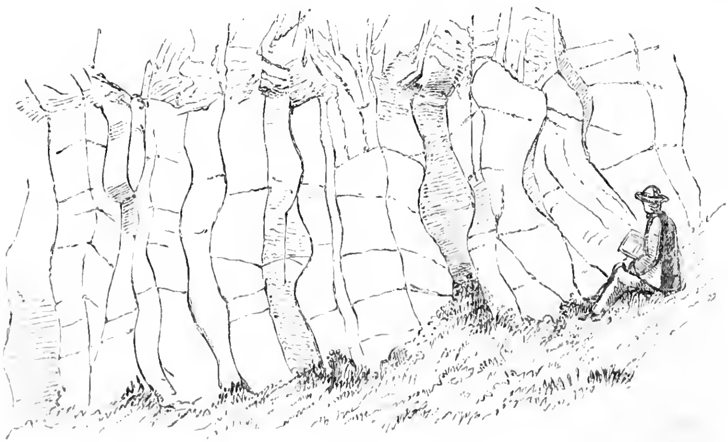
columnar beds; they also become thinner, and lose their remarkable parallelism of deposition, as well as distinct columnar structure; The upper one is now but rudely columnar, and the columns are much thicker than those of the bed below; the underlying ochre-layer is wanting, and its place is supplied by a deposit of amorphous basalt, which now attains a thickness equal to that of the superimposed columnar beds. This change of structure in the cliff-section occurs in a distance of less than three hundred yards. Below this amorphous basalt a new columnar bed of trap appears, the pillars of which are exceedingly symmetrical in every respect, and of great beauty; they are exposed for the distance of about two hundred feet, and are all inclined to the eastwards; while their upper surface, which is very even, slopes to the westward at about six to eight degrees. This group of columns is called "The Organ" (see figs. 4 and 5).

Below this bed, though not absolutely seen, the missing ochre-layer is presumed to be. If we now follow the cliff section westward, we find that the "organ-bed" in its extension to that direction, and with its dip of six to eight degrees would eventually be brought so low that more than one-half of its thickness would be emersed below the level of the sea, leaving the remainder to project above the water, and thus to form that singular looking natural pier called "The Giant's Causeway." At this spot the thickest and very nearly the most central portion of this particular lava-flow is reached, and it is worthy of remark that here the columns on the east side of the Causeway, which is about one hundred and sixty feet across, incline to the east, while on the west side they slope to the west, thus showing in their vertical arrangement a radiation from a series of centres, all following a given line, which would have very nearly a meridional direction, or in other words that of the longest axis of the lava-flow. This structure, I have no doubt, would be apparent throughout the entire of this particular bed if we had the power to examine it throughout, indeed the view which the cliffs afford of it is almost conclusive on this point, as it exposes a transverse section of it in two of its most important positions, viz., at the "Organ-" columns, near its eastern termination, and at the Causeway, close to its centre.

In the cliffs to the south of Portnoffer, adjoining the Causeway, which average from two hundred and seventy feet to three hundred and seven feet in elevation (fig. 6), the two columnar beds, which



Lign. 6.—Cliffs South of Portnoffer.



Lign. 7.—The Whin Dyke.

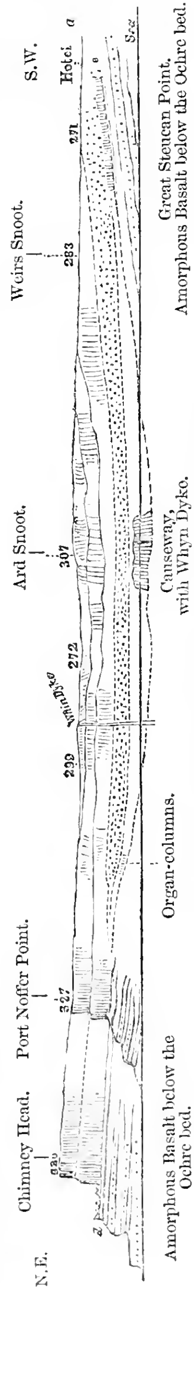
are so distinct at the summit of the "Chimney-" headland, are represented by not less than possibly four separate deposits of trap; the

two lowest, which occupy the central position of the cliff, are rudely and massively columnar, and are separated from each other by an irregular layer of rotten black shale, which at one period was searched for coal, and is still known as the "coal-mine;" the lower portion of this shale is a dull brownish-red earth. Above these columnar beds the remainder of the cliff is composed partly of amorphous trap and a group of small columns, which are bent out of the perpendicular, being overlaid by a thin layer of horizontal columns, which terminate the chief section.

At this locality the cliff is traversed from its base to its summit by a whin dyke, fifteen feet thick, the strike of which is about north-west and south-east (Lign. 7).

The projection in the coast directly south of the Causeway and overhanging it, called "Ard snoot," is three hundred and seven feet above the sea. It exhibits two well-marked columnar beds, most probably the representatives of those at the Chimney-headland. They appear to be of equal thickness, but the upper bed, which forms the summit of the cliff, exhibits small, well-formed, but partially bent, or irregularly bulged columns; while those of the lower bed are unusually large, rudely formed, and more vertical.

From the observations which I have been able to make, it would appear that the bending of basaltic columns *in situ* may be accounted for in two ways:



a, amorphous trap, columnar at its base; *d e*, great ochre bed.

Lign. 8.—Diagrammatic Section of the Coast at the Giant's Causeway, from the Chimney Head to the Steucan Point; view looking S.E.

Scale, 6 inches to 1 mile for distance and height.

first, as the result of vertical pressure applied to the columns after their perfect formation, and before the mass had quite lost its plasticity from heat; secondly, the effect of a re-heating and compression on the columns by an incandescent mass of trap being poured out on them, thus rendering them plastic to a certain depth only, an idea not improbable when it is recollected that basalt fuses at a less heat than that required to melt pig-iron. Near Portrush, on the Coleraine road, an excavation into a low knoll of amorphous trap, the base of which is formed of a thick bed of columnar basalt, affords a striking example of perfectly formed vertical columns being bent over at the top to the depth of a few feet, most likely the result of their having been re-heated and compressed by the superimposed amorphous trap. The foregoing remarks have of course no reference to columnar masses which exhibit a radiating structure, as this may be merely a rude zeolitic form of columnar arrangement, or crystallization in the basalt.

Leaving the Causeway, and proceeding along the base of the cliffs south west towards the headland called "Weirs snoot," (two hundred and eighty-five feet in elevation), we soon pass off the Causeway-bed, as it rises to that direction, or, in other words, slopes to the eastward; and, as we get near the Hotel, the pathway under the cliffs exposes the lost ochre bed of the Chimney-headland; it is here, however, very thin, and is overlaid by the western extension of the amorphous trap which was described as resting on the "Organ"-bed, or that which forms the Giant's Causeway. The base of this amorphous trap is rudely columnar to the height of from eight to ten feet from the ochre-bed, the sides of the imperfectly formed pillars being deeply waved or curved, giving them a pinched look. Many of these columns if detached would resemble a long irregularly shaped wedge or pyramid, the base or apex being up or down as chance would have it.

The exceedingly close resemblance of this rudely columnar mass to that of the Rowley Hill, near Dudley, in Staffordshire, is very striking, though they are of different geological age.

The rugged headland to the north of the Causeway Hotel, called "the Great Steucan," and the cliff called "Weirs snoot," are formed of the amorphous basalts which underlie the ochre-bed, and con-

sequently in them we have regained the same geological horizon or the beds equivalent to those forming the *base* of the Chimney-headland.

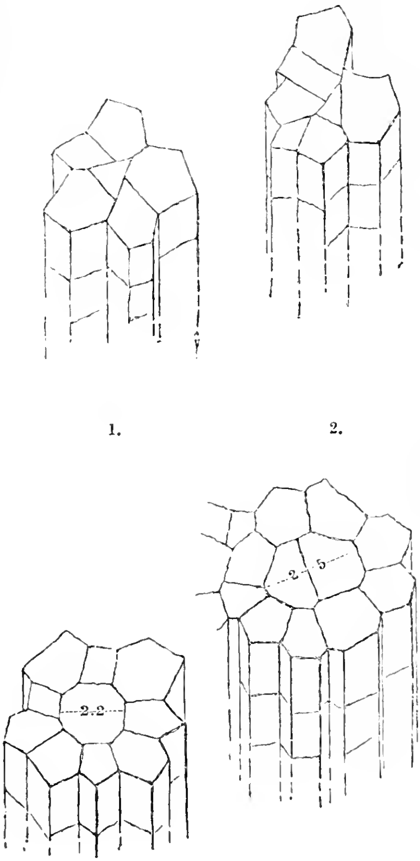
From the foregoing remarks we may infer

1st, That lava-flows are much less regular and parallel to each other in their deposition than matter deposited to form an aqueous rock.

2nd, The Basalt which forms the columnar bed known as the "Giant's Causeway" is quite a local deposit, measuring at the most two thousand six hundred feet in width, or from east to west, and appearing along the coast as a lenticular shaped bed, thinning out at either side; and it occupies a flattened trough in the amorphous basalts which underlie the great ochre-bed of the "Chimney-" headland.

3rd, The section afforded by the coast adjoining the Causeway is a cutting transverse to the longest axis of, at least, this lava-flow.

4th, The columns of this particular bed ap-



1. 2. 3 4.

Lign. 9.—Grouping of Basaltic columns.

Figs. 1 and 2.—Three sided columns surrounded by their associated pillars. Fig. 3.—The largest perfect column at the Causeway; a nonagon surrounded by its adjoining pillars. Fig. 4.—Possibly a decagon column, surrounded by nine other columns. It may, however, be merely a hexagon, and a heptagon attached by one side longer than the others—no means of proving whether the central division is prolonged below the articulation of the pillar shown in the view.

pear to radiate from aline of imaginary centres, which are coincident with the longest axis of the flow; the inner circumference of these radiations being defined by the upper surface of the lava-bed, and hence the upright planes of columnar crystallization strike at right angles downwards from what must have been the primary cooling surface of the mass, that surface from the first having been slightly depressed in its centre.

5th, The columns which form the "Giant's Causeway" exhibit a peculiar beauty and accuracy of form, being in every respect more symmetrical than those of any of the other columnar basalts of the district, with the one exception of the "Organ-"columns, and on this account alone an observer would be led to identify them as belonging to the same bed.

THE CARBONIFEROUS SYSTEM IN SCOTLAND CHARACTERIZED BY ITS BRACHIOPODA.

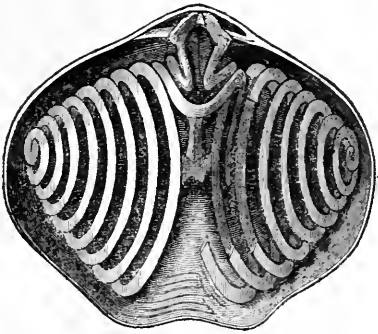
By Thomas Davidson, Esq., F.R.S., F.G.S., Hon. Member of the Geological Society of Glasgow, etc., etc.

(Continued from vol. ii., *page* 477.*)*

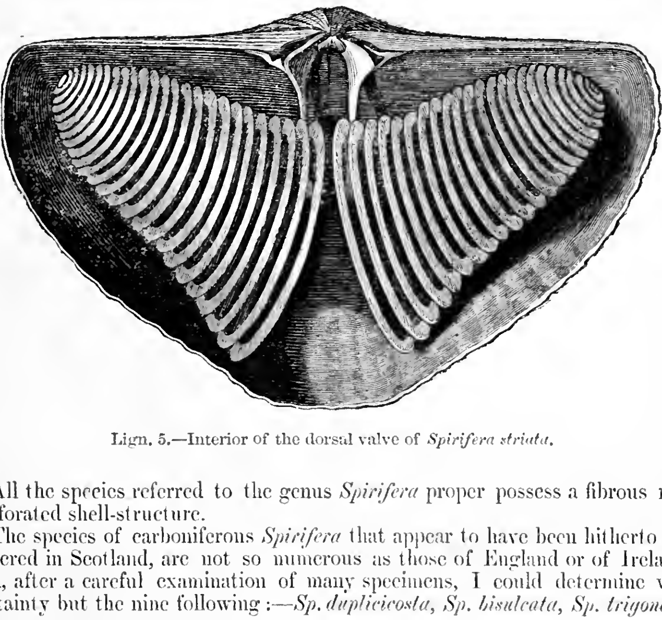
Genus Spirifera. Sowerby. 1815.

The shells of which this genus is composed differ much in their external shape and appearance, hence the great difficulty of correctly determining the limits of certain species. The character of this extinct genus are now so well understood that it is scarcely necessary to make any further allusion to the subject; but we may briefly repeat, for the sake of the less initiated, and in order to shorten the descriptions of the various species, that all possess a straight hinge-line, and a triangular or sub-parallel area, which is divided by a triangular fissure, this last being more or less covered, or contracted, by the means of one or two curved plates, to which the term pseudo-deltidium has been applied. The pseudo-deltidium is rarely preserved in the carboniferous specimens, but did certainly exist in the perfect or living individuals. The valves are articulated by the means of curved teeth developed on either side of the fissure in the ventral valve, and which fit into corresponding sockets in the opposite or dorsal one. In the larger valve the teeth are supported by vertical plates of greater or lesser dimensions, and in the space between these on the bottom of the shell are situated the muscular impressions. The adductor, or occlusor muscle leaves a narrow mesial oval-shaped scar, and on either side are situated the cardinal, or divaricator muscular impressions. In the interior of the smaller, or dorsal valve there exists two large conical spiral coils, which nearly fill the interior of the shell, the ends being directed outwardly towards the cardinal angles, while the bases of the hollow conical spires nearly meet at

the hinge side, but are wide apart in front. The hinge-plate is divided into two portions, to which the principal stems are attached, and in the notch under the extremity of the umbonal beak there exists a calcareous projection, to which the term "cardinal" process has been applied, and to which was attached one of the extremities of the divaricator muscle. A little lower down, on the bottom of the valve, are seen four large elongated impressions, produced by the adductor, and which have been recently designated as the anterior and posterior occlusor muscles by Mr. Hancock.



Lign. 4.—Interior of *Athyris ambigua*, showing the spiral appendages.



Lign. 5.—Interior of the dorsal valve of *Spirifera striata*.

All the species referred to the genus *Spirifera* proper possess a fibrous non-perforated shell-structure.

The species of carboniferous *Spirifera* that appear to have been hitherto discovered in Scotland, are not so numerous as those of England or of Ireland; and, after a careful examination of many specimens, I could determine with certainty but the nine following :—*Sp. duplicicosta*, *Sp. bisulcata*, *Sp. trigonalis*,

Sp. pinguis, *Sp. ovalis*, *Sp. glabra*, *Sp. Carlukiensis*, *Sp. Urii*, and *Sp. lineata*; and it must also be further noted that some of these have hitherto proved exceedingly rare, and that good examples of several others are with difficulty obtained.

VIII.—Spirifera duplicicosta. Phillips. Pl. xii.,* figs. 14, 15.

Spirifera duplicicosta, Phillips, Geol. York., vol. ii., p. 218., pl. x., fig. 1, 1836; and Dav. Carb. Mon., p. 24, pl. iii., figs. 7—10, pl. iv., figs. 3, 5—11.†

This shell varies much in external shape, being either transversely sub-rhomboidal or somewhat longer than wide. The valves are moderately convex, with a more or less elevated mesial fold in the dorsal, and a corresponding sinus in the ventral one. The hinge-line is shorter than the width of the shell, the area of moderate breadth, and the beak more or less incurved. The valves are ornamented by numerous radiating ribs, which augment in number at various distances from the beaks by intercalation and bifurcation. The ribs vary, however, somewhat in general appearance in different specimens, being only here and there duplicose, or having three or four ribs clustered together; the term *duplicicosta* is, therefore, very inappropriate, since many species of the genus present the same peculiarity. *Sp. duplicicosta* is the largest Scottish spirifer with which I am at present acquainted, some specimens measuring twenty-one lines in length by about thirty in width; and it has also been sometimes confounded with *Sp. striata* of Martin—a closely allied species, but of which I am not acquainted with any well authenticated Scottish example.

Perfect specimens of this shell are rarely found, although thousands of crushed or broken valves occur in a bed of limestone, four feet in thickness, near Campsie, at Balgrochan, and Corrie Burn, in Stirlingshire. In Ayrshire it is found at West Broadstone, near Beith; at Craigie, near Kilmarnock; and at Auchenskeigh, near Dalry. In Lanarkshire it has been collected at Brockley, near Lesmahago. It has been also found in West Lothian and Bute.

IX.—Spirifera bisulcata. Sowerby. Pl. xii., figs. 19—25.

Spirifera bisulcatus, J. de C. Sow., Min. Con. Tab., 492, figs. 1, 2, 1825; *Spirifera bisulcata*, Dav. Mon. Carb., p. 31, pl. iv., fig. 1, pl. v., fig. 1, pl. vi., figs. 1—19, and pl. vii., fig. 4.

This shell is either transversely semi-circular or obscurely sub-rhomboidal, the valves being almost equally deep or convex. The hinge-line is sometimes rather shorter than the greatest width of the shell, with the cardinal angles rounded; or as long, with angles of variable projection. The area is sub-parallel, of moderate width, and divided by a triangular fissure, the beaks incurved, and at times very approximate. In the dorsal valve the fold is somewhat angular, and of greater or lesser elevation, but is at times so flattened that it hardly rises above the general convexity of the valve. The sinus is of moderate depth. Each valve is ornamented with from thirty to fifty obscurely-rounded ribs, which increase in number by the occasional bifurcation or intercalation of smaller ribs at various distances from the beaks. On the mesial fold they are arranged into three groups, separated by sulci of greater depth, the whole surface being also regularly covered with imbricating striæ. The variations in shape presented by this species are quite perplexing, and it is probable that several so termed species will require to be added to its synonyms. Among these we may mention *Sp. semicircularis*, Phillips, and *Sp. crassa*, de Koninck, certainly; and possibly *Sp. grandicostata* of M'Coy.

* This plate forms part of the second volume of the "Geologist."

† For list of synonyms, &c., see my monograph published by the Palæontographical Society, all details not absolutely required having been omitted in the present monograph.

Sp. bisulcata is one of the most abundant of our Scottish spirifers, the largest example with which I am acquainted measuring eighteen lines in length by twenty-eight in width and thirteen in depth.

This shell has presented an extensive vertical range; in Lanarkshire it is found at Garc, at a depth of two hundred and thirty-nine fathoms below the horizon of the "Ell coal;" at Raes Gill at three hundred and forty-three; Langshaw Burn three hundred and fifty-four; Mosside three hundred and seventy-three; and at Braidwood Gill three hundred and ninety-seven fathoms. Ure gives us a good figure of a specimen he had found at Lawrieston.* It has been collected at Birkwood, near Lesmahago, and at Robroyston, to the north of Glasgow. In Stirlingshire it is not rare at Craigenglen, Balglass Burn, Mill Burn, Corrie Burn, and in the Campsie main limestone. In Dumbartonshire, at Castleeary; in Renfrewshire, at Barrhead, and Arden quarry, Thornliebank; in Ayrshire, at Roughwood, and West Broadstone, near Beith; Auchenskeigh, near Dalry; Craigie, near Kilmarnock; Monkredding and Goldcraig, near Kilwinning; and Neathernewton, parish of London, &c. It has also been obtained from Arran and Bute.

X.—Spirifera trigonalis. Martin. Pl. xii., figs. 16—18.

Conchyliolithus anomites trigonalis, Martin, Petrif. Derb. tab. 36, fig. 1, 1809; and Dav. Mon. Carb., p. 29, pl. v., fig. 28—33.

In shape it is transversely trigonal, with its hinge-line as long, or slightly shorter, than the greatest breadth of the shell; the area is sub-parallel, and of moderate width, the valves being almost equally deep; the mesial fold is elevated, angular, and often produced beyond the frontal margin of the lateral portions of the valve; it is also more often divided by three principal ribs, of which the central one is at the same time the largest and most extended; the sinus is deep, and divided by from three to five longitudinal ribs, of which the central one is also the most developed. Besides these, the surface of each valve is ornamented with from fourteen to twenty-two simple ribs.

This is also a common shell in Scotland, and does not appear to attain the dimensions of *Sp. bisulcata*, with which it has been sometimes confounded. Dr. Fleming was certainly mistaken when, at p. 374 of his "History of British Animals," he referred Ure's pl. xv., fig. 1, to the species under description.

In Lanarkshire, *Sp. trigonalis* is found at three hundred and forty-three fathoms below the "Ell coal" at Waygateshaw, and at Braidwood at three hundred and seventy-five. It occurs also at Brockley, near Lesmahago; at Moodies Burn, north-east of Glasgow, and in the main limestone near Campsie; and Renfrewshire, at Arden quarry, near Thornliebank; in Ayrshire, at West Broadstone, near Beith; Craigie, near Kilmarnock; and at Auchenskeigh, near Dalry. In Midlothian, at Dryden, near Edinburgh; and at Courland, near Dalkeith. It has also been found in West Lothian and in Bute.

XI.—Spirifera pinguis. Sowerby. Pl. xii., fig. 28.

Spirifera pinguis, Sow. Min. Con., vol. iii., p. 125, tab. 271, 1820; *Spirifera pinguis*, Dav. Mon. Carb., p. 50, pl. x., figs. 1—12.

When full grown (under favourable circumstances) it is transversely oval, but is also sometimes as wide as long, or even (though more rarely so) longer than wide. The hinge-line is usually shorter than the greatest breadth of the shell, the cardinal angles being rounded, and the area narrow. The dorsal valve is not quite so deep nor so convex as the opposite; the fold is moderately

* It may be as well to mention that Mr. Bennie has ascertained that Lawrieston is the old name for a place a few hundred yards from the Capel Rig quarry, and now known by the denomination of Brankamhall, East Kilbride.

wide and produced, smooth, and slightly depressed along its centre. In the ventral valve the sinus is regularly concave and smooth, each valve being ornamented with from sixteen to thirty rounded or flattened ribs.

This species appears to be rare in Scotland, for I am acquainted with but a single small example, which was derived from carboniferous limestone to the north of Glasgow, and now belongs to the Museum of Practical Geology. It measures eleven lines in length by twelve in breadth and ten in depth.

XII.—Spirifera ovalis. Phillips. Pl. xii., figs. 26, 27.

Spirifera ovalis, Philips, Geol. of York., vol. ii, p. 219, pl. x., fig. 5, 1806; and Dav. Mon. Carb., p. 53., pl. ix., figs. 20—26.

This shell is, transversely or elongatedly oval, with a very short hinge-line, and rounded cardinal angles; the area is triangular, and more often wider than high. The dorsal valve is moderately convex, and much less deep than the opposite one, with a smooth, broad, flattened, mesial fold. In the ventral valve the beak is small, tapering, and incurved; the sinus rather shallow, commencing at the extremity of the beak, it extends to the front and is ornamented with one or two longitudinal ribs placed on either of its sides. From eighteen to twenty simple flattened ribs ornament the surface of each valve. *Sp. ovalis* appears to be an uncommon species in Scotland, and to which Prof. Fleming, in 1828, had applied the name *exarata*; but as the last named author never figured his shell, and that the description, "Perforated valve, with broad, smooth, flattened ribs, divided by shallow, narrow furrows; beak gibbous, incurved; hinge very short," might apply equally well to several other species, I should question the propriety of adopting the term *exarata* (notwithstanding its priority of date) in preference to the well-known one by Phillips, and especially so as Dr. Fleming further observes that, although he has frequently found the perforated valve, it was always mutilated or without the other valve, with which he was not acquainted, as may be seen from the original fragment represented in our plate, and which was kindly communicated by the author.

Sp. ovalis has been found in the Corrie Burn beds, Stirlingshire; also in West-Lothian and at West Broadstone in Ayrshire. In Lanarkshire at Brockley, near Lesmahago.

XIII.—Spirifera glabra. Martin. Pl. xii., figs. 32—34.

Conchyliolithus anometes glaber, Martin Petrif. Derb., pl. xlviii., figs. 9, 10, 1809, and Dav. Mon. Carb., p. 59, pl. xi., figs. 1—9, pl. xii., figs. 1—5, 11, 12.

This shell varies to such an extent, that it is difficult to assign any permanent character; the shape is, however, more often transversely oval, and rarely longer than wide. Both valves differ in degree of convexity, the ventral one being generally the deepest. The hinge-line is shorter than the greatest width of the shell, with rounded cardinal angles and the beak more or less approximate and incurved.

The ventral hinge area is triangular and of moderate dimensions, the dorsal one being narrow and sub-parallel, the mesial fold is either slightly and evenly convex, rising gradually from the lateral portions of the valve, or abruptly elevated with a longitudinal depression along its middle; the sinus varies likewise in depth according to the specimens. Externally both valves are generally smooth, but sometimes a few obscurely marked flattened ribs may be observed on the lateral portions of the shell.

This species, at times, attains thirty-two lines in length by forty-three in width, and twenty-six in depth; but no Scottish specimens I have hitherto seen attain half those proportions.

At Harestanes and Langshaw Burn in Lanarkshire, *Sp. glabra* is found at

three hundred and seventy-five fathoms below the "Ell coal;" occurs also at Middleholm, near Lesmahago and East Kilbride. In Stirlingshire at Corrie Burn and Campsie main-limestone. In Renfrewshire at Orchard-quarry, near Thornliebank. In Ayrshire, at West Broadstone, Beith, and at Auchenskeigh, near Dalry, etc.

XIV.—Spirifera Carlukiensis. Davidson. Pl. xii., fig. 29.

Spirifera Carlukiensis, Dav. Mon. Carb., p. 59, pl. xiii., fig. 14, 1857.

Shell minute, nearly circular and smooth; valves almost equally deep; dorsal valve regularly convex, most so at the umbone. Ventral valve convex, with a narrow mesial depression or furrow commencing at a short distance from the extremity of the beak and extending to the front, where it indents the margin of the opposite valve. The beak is small, pointed, and but slightly incurved; the hinge-line much shorter than the greatest width of the shell, with its cardinal angles rounded, area small, triangular. This little shell does not appear to have ever greatly exceeded two lines in length by two and a-half in breadth. It was discovered for the first time at Hill Head in Lanarkshire, at about three hundred and fifty-six fathoms below the "Ell coal," along with *Sp. Urii*, but it is a rare species, for in every hundred or more specimens of the last named shell that is collected, a single example of *Sp. Carlukiensis* would occur. It has also been recently discovered near Strathavon in a bed of shale almost entirely composed of *Sp. Urii*, and is there nearly as rare as at Hill Head.

XV.—Spirifera Urii. Fleming. Pl. xii., fig. 30.

Spirifer Urii, Fleming, British Animals, p. 376, 1828; *Spirifera Urii*, Dav. Mon. Carb., p. 58, pl. xii., figs. 13, 14.

This little species is sub-orbicular, and rather wider than long; the hinge-line shorter than the greatest breadth of the shell, and the cardinal angles rounded. The dorsal valve is semicircular and slightly indented in front, with a narrow hinge area; it is nearly flat or slightly convex, especially at the umbone, from whence a shallow mesial furrow extends to the front. The ventral valve is much deeper and more convex than the opposite one, with a lengthened incurved beak and longitudinal furrow, which, originating at the extremity of the beak, is continued to the front. The area is small and triangular in shape; when perfect the exterior of the shell was covered with numerous closely implanted spines, but which are rarely preserved in the fossil, so that the shell is generally found smooth or covered with minute pustulate markings, which are produced by the fracture of the spines close to their bases.

This abundant and interesting little species was noticed, and figured for the first time by Ure, in 1793, (History of Rutherglen and East Kilbride, p. 313, fig. 12.) but named only thirty-five years later by Dr. Fleming. Ure's figure is not, however, very correct, for it does not represent the incurvature of the beak which is always present, nor is the area ever as wide as is there depicted. *Sp. Urii* has received several other names, for it is highly probable (if not perfectly certain) that the *Sp. Clannyana*, King,* from the Permian formation, and

* The re-occurrence of several carboniferous species in the Permian strata appears to be almost certain, although such has been doubted by several palæontologists. It is therefore probable that the following carboniferous (C), and Permian (P) shells are identical, notwithstanding that they have received distinct specific names according to the strata in which they have been discovered. Thus *Terebratula sacculus*, C., = *Sp. sufflata*, P; ? *Spirifera Urii*, C, = *Sp. Clannyana*, P; *Spiriferina octoplicata*, C., = *Sp. cristata*, P.; *Camarophoria crumena*, C., = *Ca. Schlotheimi*, P.; *Ca. globulina*, P., = *Ca. rhomboidea*, P.; and the *Lingula Credneri*, P., have been found in the carboniferous strata by Mr. Kirkby. The re-occurrence of species is a subject that has been too often supposed impossible, and treated accordingly.

the *Sp. unguiculus*, Phillips, from the Devonian series, are only synonyms of the present species, and to which must also be added the *Sp. Goldfussiana* of Prof. de Koninck. It does not appear to have often exceeded about four lines in length by four and a-half in width and two in depth, but is usually a much smaller shell, at least so in Scotland. *Sp. Urii* is certainly the most abundant of Scottish spirifers, and may be picked up by thousands in several localities, such as at Hill Head, in Lanarkshire, where it occurs at three hundred and fifty-six fathoms below the "Ell coal," and three hundred and seventy-five at Kilcadzow. It is found plentifully on the east bank of the Avon, near Strathavon; and at Coalburn, near Lesmahago. In Stirlingshire it has been found in three different stages, viz., the Craigenglen beds, under the main-limestone, and in the black-limestone and shale of South Hill, Campsie.

XVI. Spirifera lineata. Martin. Pl. xii., fig. 31.

Conchiliolithus anomites lineatus, Martin, Petrif. Derb., tab., xxxvi., fig. 3, 1809; and Dav. Mon. Carb., p. 62, pl. xiii., figs. 1—13.

In shape this shell is either transversely oval or sub-orbicular, the hinge-line being much shorter than the width of the shell, and the cardinal angles rounded; the beaks are incurved and more or less approximate, the area small. Ventral valve evenly convex, and rarely possessing any mesial elevation, or fold, while the dorsal valve is rather deeper than the opposite one, and either uniformly convex, or presenting a shallow longitudinal depression, which becomes most apparent towards the front. Externally the surface was covered with numerous concentric ridges, rarely in any place more than a line apart, but usually very much closer, and from each of which departed numerous contiguous closely packed spines, which thus formed a series of rows, or fringes over the shell. When the spines are absent, which is the general condition in which the shell is found, the surface appears marked by numerous and regularly imbricated lines, the radiating ones being produced by the small elevations from which each spine took its birth, as I have attempted to show in the enlarged representation, fig. 31*c*, and which is very different from the irregular manner in which the spines are scattered over the surface of *Sp. Urii*, of which fig. 30*e*. is an enlarged illustration. *Sp. lineata* is a common shell in the carboniferous limestone and shales of Scotland; but none of the examples I have yet seen attained the dimensions presented by some which occur both in England and Ireland.

At Gare in Lanarkshire *Sp. lineata* occurs at two hundred and thirty-nine fathoms lower than the "Ell coal;" at Braidwood, three hundred and forty-three; at Harestanes, three hundred and seventy-five; and at Nellfield, four hundred and ten. It may also be collected at Brockley, and Middleholm near Lesmahago. In Ayrshire it occurs at Roughwood, and West Broadstone near Beith; Hallerhirst, Stevenston; and Craigie near Kilmarnock. In Renfrewshire, at Barrhead; and at Arden and Orchard quarries near Thornliebank. In Dumbartonshire, at Castlecary. In Stirlingshire, under the main limestone and in the Calmy limestone or Balquarhage beds, Campsie, as well as at Corrie Burn. In Mid Lothian it is not rare at Dryden, near Edinburgh; and at Courland, near Dalkeith. Dr. Fleming mentions Dreghorn and Ayr, and it was also found in Arran by Prof. Ramsay.

Sub-genus Spiriferina. D'Orbigny. 1847.

The species located in this sub-genus differ from *Spirifera* (which they resemble in external shape) by the perforations or canals which traverse their shells, as well as by the development of a large elevated mesial septum in the interior of the ventral valve, to the sides of which was attached the adductor, or occlusor muscle.

Spiriferina cristata var. *octoplicata*, and *Sp. insculpta* are the only two species belonging to this sub-genus that have been hitherto discovered in our Scottish carboniferous rocks.

XVII.—Spiriferina cristata, var. octoplicata. J. de C. Sowerby. Plate xii., figs. 36-38.

Spirifer octoplicatus, Sowerby, Min. Con., p. 120, pl. 562, figs. 2, 3, 4: 1827.
Spiriferina cristata var. *octoplicata*, Dav. Mon. Carb., p. 38, pl. vii., figs. 37-47.

In external shape this shell is more often transversely sub-rhomboidal, with nearly equally convex valves, the hinge-line being either as long or rather shorter than the greatest width of the shell, with acute or rounded cardinal angles; the area is triangular, slightly concave, and of variable width. In the dorsal valve the mesial fold is usually composed of a single rib, which is often flattened along the middle; but in some rare examples there exists a rudimentary one on either of its slopes, so that in some instances the fold assumes towards the front an obscurely biplicated, or triplicated appearance. In the ventral valve the sinus is deep and acute, while both valves are ornamented with from eight to twelve angular ribs, which are (as well as the sinus and fold) closely covered with numerous small granular (spinose) asperities, which give to the shell a rough feel and appearance. The shell-structure is also perforated by minute tubuli, of which the external orifices may be readily detected by the aid of a common lens. In the interior of the ventral valve a sharp mesial septum rises from the bottom of the valve, and partly divides the spiral cones. The species we are at present describing varies much in general shape, as well as by the number of its ribs; it is never a large shell, although some English specimens have been found more than double the size of any Scottish one that has come under my observation, none of these last having exceeded some six lines in length by about seven in breadth. I am also still inclined to maintain the opinion expressed in my monograph, namely that the shell under description bears so close a resemblance to the Permian *Sp. cristata* of Schlotheim that it cannot be specifically separated, and could not in any case claim more than a varietal distinction.

Sp. octoplicata has been found at Gare, in Lanarkshire, at two hundred and thirty-nine fathoms below the "Ell coal;" at Braidwood Gill, three hundred; at Hallcraig Bridge, three hundred; and at Raes three hundred and forty-one fathoms. The shell has also been collected in the same county at Brockley, near Lesmahago; Auchtentibber and Calderside, High Blantyre; Capel Rig, East Kilbride; Strathavon; and Robroyston, north of Glasgow. In Renfrewshire, at Arden- and Orchard-quarries, Thornliebank; in Stirlingshire, in the Corrie Burn beds; in Ayrshire, at Roughwood and West Broadstone, Beith; Auchenskeigh, near Dalry; Hallerhirst, Stevenston; Craigie, near Kilmarnock; and Meadowfoot, near Drumclog. It has also been found in West Lothian, as well as in the Island of Arran.*

* *Sp. cristata* var. *octoplicata* is a common shell in the lower red carboniferous sandstone of Kildress; in Ireland *Sp. partita* of Portlock being a synonym.

Since the publication of the first pages of my paper in the December number of the "Geologist," Mr. Kelly has informed me that the quotation at p. 465 relative to the arrangement of the Carboniferous system in Ireland does not represent his views, and he has kindly furnished me with the following note.

"My subdivisions are, 1, Old Red Sandstone; 2, calciferous-slate; 3, limestone; 4, coal measures. The Kildress red and yellow sandstone, which is one, is not lower coal-measures; it lies" (as I have stated) "below the calciferous-slate. Again, the Old Red Sandstone is not that which predominates. This rock averages about one thousand feet thick in Ireland, and is not much exposed, being covered with limestone. Our calciferous slate is considerable in thickness, and in the best developed places (Clonea, near Dungarvan) is half of it made up of thin bands of limestone, the other half calcareous shale. The fossils in both inseparable, so that the calciferous slate and mountain-limestone might be considered as one division, but it

XVIII.—SPIRIFERINA INSCULPTA. Phillips. Pl. xii., fig. 35.

Spirifera insculpta, Phillips, Geol. of Yorkshire, vol. ii., p. 216, pl. ix., figs. 2, 3, 1836; and Dav. Mon. Carb., p. 42, plate vii., figs. 48-55.

In shape it is more or less semi-circular, and about one-third wider than long; the hinge-area is straight and as wide as the greatest width of the shell. The area large, triangular, and but slightly curved; beak small, and not much produced. Both valves are about equally convex; the ventral one is ornamented with five (rarely seven) large bold angular ribs, of which the central one exceeds the others somewhat in proportion, and corresponds with a deep angular sinus in the opposite valve. All the ribs are sculptured, or closely intersected with small concentric laminæ, which give to the perfect shell a very elegant appearance. This is a rare Scottish shell; it occurs at Gare, in Lanarkshire, at two hundred and thirty-nine fathoms below the "Ell coal."

FAMILY RHYNCHONELLIDÆ.

Of this family the genera *Rhynchonella* and *Camarophoria* alone have been hitherto discovered in the Scottish carboniferous strata. Of the first we know but two species, and one only of the second ; while in England eight of *Rhynchonella* and three of *Camarophoria* have been found.

GENUS RHYNCHONELLA. Fischer. 1809.

The shells composing this genus vary much in their external shape and appearance, some being transverse, others rounded or angular, smooth, variously ribbed, or striated. The valves are generally convex, with or without a mesial elevation or sinus; the beak is acute, prominent, or so greatly incurved as to touch and even to overlie the umbone of the opposite valve; the foramen is variable in its dimensions and shape, being placed under the extremity of the beak, and entirely or partially surrounded by a deltidium. The shell-structure is fibrous and not perforated; and the valves articulate by the means of two teeth in the ventral, and corresponding sockets in the dorsal valves. The

is perhaps more correct to separate them into two. The Carboniferous, or Hibernian limestone is fifty feet thick at Drumguin in Tyrone, it is about fifteen hundred feet thick at Black Head in Clare, and occupies above twenty thousand square miles in Ireland. This greatly predominates; the coal-measures are two thousand feet thick, or more. The Old Red sandstone, at Kildress in Tyrone, and the Old Red Sandstone of Herefordshire are two very different things. The first belongs to the Carboniferous system; the latter is a subdivision of the Silurian rocks."

My mistake was not therefore in in the order of superposition of the different strata, which Mr. Kelly admits to be correct; but in having endeavoured to reconcile the succession of the Carboniferous strata in Scotland with that of Ireland by applying Mr. Page's general denomination of "Lower Coal-measures" to that group which embraces all the alternations of strata which lie between the Old Red Sandstone and the mountain- or Carboniferous-limestone. The term, however, would not apply to Ireland, since in the sister island no lower coal-measures underlie the mountain-limestone, as we find to be the case in Scotland, and where Mr. Kelly suggests that the limestone may be moved up a stage, with coal-measures below it. It must appear evident to all that the term Old Red Sandstone cannot be retained for a Silurian, Devonian, and Carboniferous rock, and this is the reason why I was, and still am, so averse to applying the term, or forming a subdivision by that name for those Irish red and yellow sandstones full of carboniferous fossils; for if the Calciferous- and mountain-limestone might, according to Mr. Kelly's own statement, be united into a single division on account of the similarity of their fossils, as a palæontologist, I should add that the same reasoning might equally well apply to the red sandstone of Kildress, for there also we find exactly the same fossils as those which occur in the calciferous and carboniferous-limestone. I should therefore suggest that geologists should drop the term "old," and in their subdivisions of the Carboniferous group say, 1, Lower carboniferous red and yellow sandstone; 2, calciferous slate; 3, carboniferous-limestone; and, 4th, coal-measures, by which means the vexed question relative to the Old Red Sandstone would not be interfered with as far as the Carboniferous system is concerned. It is also well known that Mr. Kelly is of opinion that no Devonian rocks occur in Ireland; while Sir R. Murchison believes that there exists there also a series of many thousand feet of shales and grits above the highest Upper Silurian which represents precisely in time the mass of the Devonian rocks; this, however, has nothing to do with the red and yellow sandstone of Kildress which undoubtedly forms part of the Carboniferous system.

[illegible]

[illegible] happy time may [illegible] of my friends and readers, and to my enemies [illegible] that one day at least, God bless them.

[illegible] good and sincere friend, Thos. [illegible] for his excellent contributions on the Scottish [illegible] other excellent friends, H. C. Salmon, Esq., [illegible] Esq., Dr. Grid[illegible] T. Rupert Jones, Esq., G. V. [illegible] and my other contributors.

[illegible] my best thanks to my very numerous kind [illegible] they have given me [illegible] to the interesting questions [illegible] so light as these kindly [illegible] family link [illegible] of geologists.

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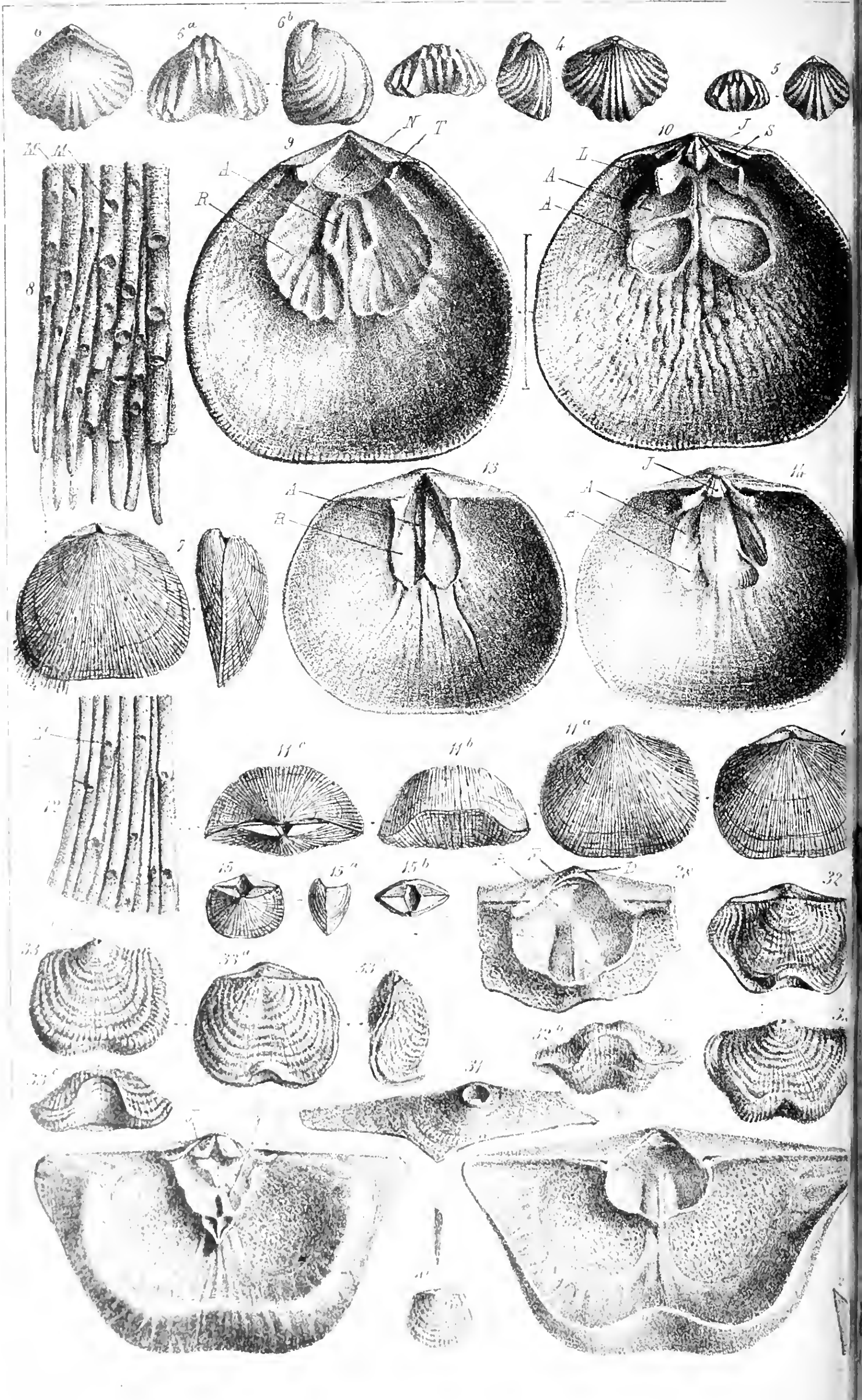

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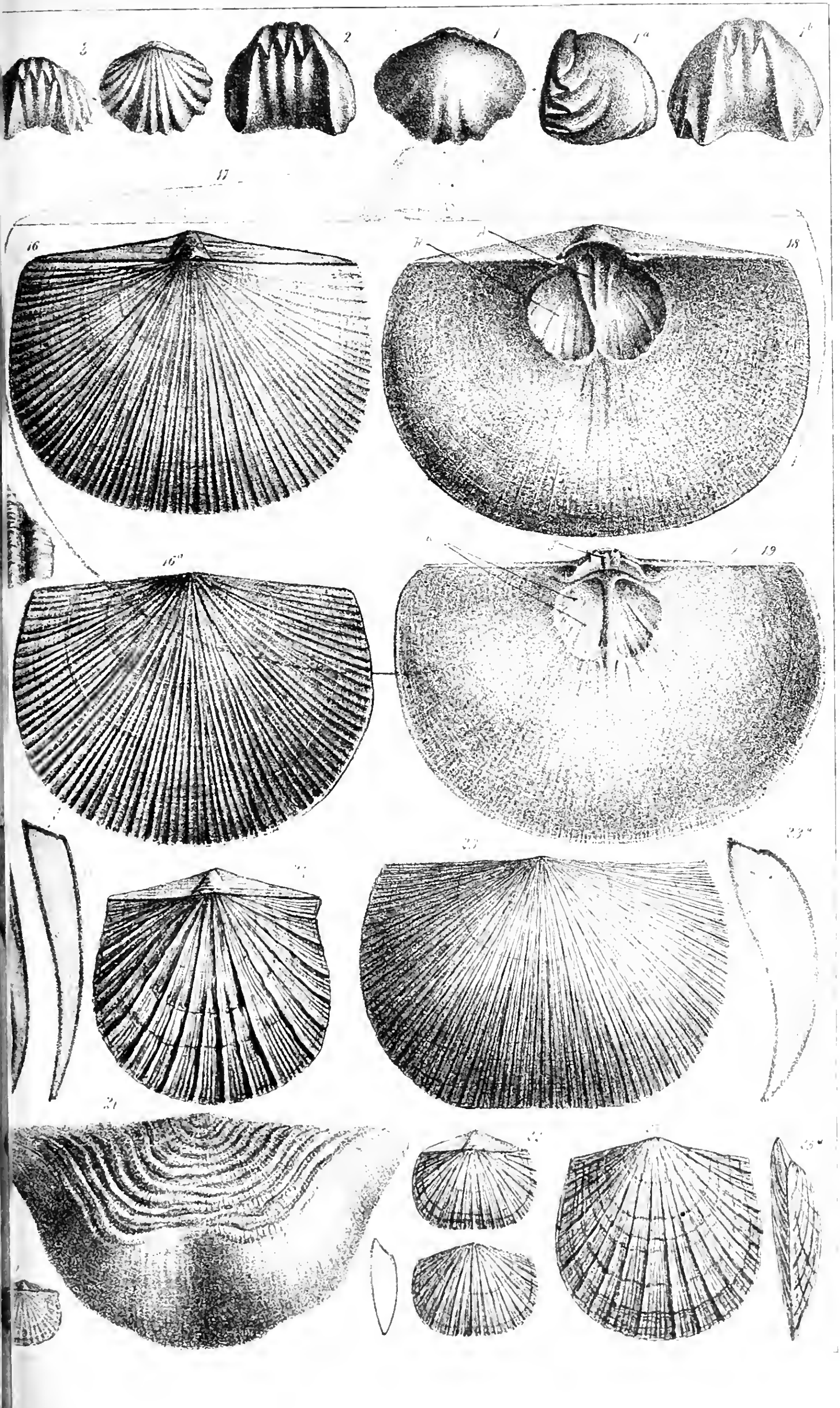
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bank; in Ayrshire, at Hyndberry Bank, parish of Loudon, also at West Broadstone, near Beith; in Stirlingshire, in the main limestone, Campsie, and Mill Burn.

XX.—RHYNCHONELLA PLEURODON. Phillips. Pl. i., figs. 3—5.

Terebratula pleurodon, Phillips, Geol. of York., vol. ii., p. 222, pl. xii., figs. 25—30, 1836; and Rh. id., Dav. Carb. Mon., p. 101, pl. xxiii., figs. 1—15.

All the Scottish specimens of this common shell which have hitherto come under my notice, were of small dimensions, and very variable in their shape, but more often transversely oval, and rarely longer than wide. When young the valves were sometimes compressed, but with age became more convex, and at times even gibbous; the beak is small, moderately produced, with a small circular foramen under its angular and slightly incurved extremity, and which is surrounded and a little separated from the hinge-line by a deltidium. The mesial fold usually occupies one-third of the shell, and is most elevated above the front, the sinus in the ventral valve being of moderate depth. The ribs are angular, and extend over the entire surface of the valves, and vary in number from ten to twenty-four in each valve; of these three to five, and even sometimes nine, compose the fold.

Many undoubted specimens of *R. pleurodon* possess but three ribs on the mesial fold; and it was for this variety that Professor M'Coy proposed, in 1844, the name *Atrypa triplex*, but which is now superfluous.

At Gare, in Lanarkshire, *R. pleurodon* is found at two hundred and thirty-nine fathoms under the "Ell coal," and three hundred and seventy-five at Braidwood. At Capel Rig, East Kilbride, it is very abundant, but nearly every example is crushed; it occurs also at Brockley, near Lesmahago, Calderside and Auchentibber, High Blantyre. In Dumbartonshire, at Neatherwood, near Castlecary. In Ayrshire, at Hallerhirst, Stevenston; Loudon; Craigie, near Kilmarnock, and West Broadstone, Beith. In Stirlingshire it occurs in several stages: at Craigenglen, Balglass, Mill Burn, Balgrochen, and Corrie Burn. In Renfrewshire, at Barrhead.

GENUS CAMAROPHORIA. King. 1844.

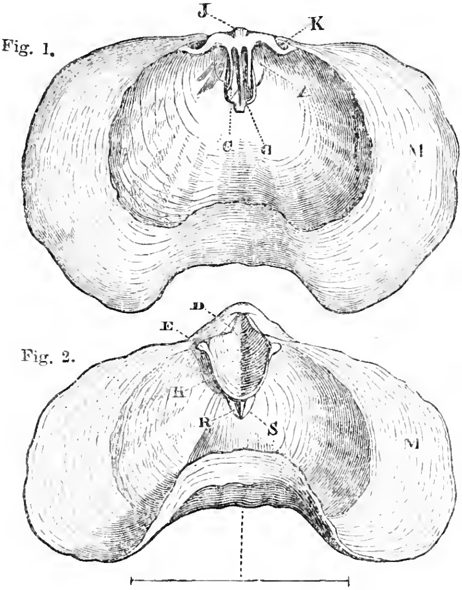
The external shapes and character resemble much those of *Rhynchonella*. The beak is entire, acute, and more or less incurved, under the extremity of which a small fissure is sometimes exposed. The valves articulate by the means of teeth and sockets. In the ventral valve the dental plates are conjoined at their dorsal margins, forming a trough-shaped process affixed to a low medio-longitudinal plate. In the dorsal valve the space between the sockets is occupied by a small cardinal muscular protuberance, on either side of which two long slender processes curve upwards, to which were no doubt attached the free cirrated spiral fleshy arms. From beneath the cardinal process a high vertical mesial septum extends to a little more than a third of the length of the valve, supporting along and close to its upper edge a spatula-shaped process, considerably dilated towards its free extremity, and projecting, with a slight upward curve, to nearly the centre of the shell. Shell structure fibrous, not perforated.

XXI.—CAMAROPHORIA CRUMENA. Martin. Pl. i., fig. 6.

Conchyliolithus anomites crumena, Martin, Petrif. Derb., tab. xxxvi., fig. 4, 1809; *Terebratula Schlotheimi*, Von Buch, Ueber Terebratula, 1834; and Dav. Mon. Carb., pl. xxv., figs. 3-9.

This species is more often transversely oval, but sometimes also as long, or longer, than wide, and trigonal in shape. The valves vary in degree of con-

vexity, as well as in the character of their ribs, which either cover the entire shell, or become obsolete towards the beaks. When perfect, the valves pos-



Lign. 7.—*Camarophoria crumena.*

Fig. 1.—Interior of the Dorsal Valve. Fig. 2.—Interior of the Ventral Valve.

A, adductor, or occlusor muscular impressions (?); C, curved processes, to which were affixed the fleshy spiral arms; D, deltidium; E, teeth; H, conjoined dental plates or trough-shaped process; J, cardinal process; K, sockets; M, marginal expansions; O, spatula-shaped process, or visceral support; R, cardinal, or divaricator muscular scars (?); S, septum.

sessed marginal expansions, but which are rarely preserved in the fossil. The mesial fold differs in width and elevation according to the number of ribs which ornament its surface, these varying from two to seven, each valve being furnished with from twelve to twenty ribs. The sinus is of moderate depth.

Of this species I am acquainted with but a single well-authenticated example, which was found many years ago in West Lothian by the late Dr. Fleming.

(To be continued.)

BRITISH ASSOCIATION MEETING.

(Continued from page 485).

On the Ossiferous Caverns at Oreston. By Henry C. Hodge, of Plymouth. Read before the Geological Section, Sept. 17, 1859.

The constant removal of immense masses of limestone required for the purposes of the Breakwater at Plymouth, during the past half century, has from time to time brought before the attention of geologists a series of remarkable cavernous fissures of great interest, from the number and variety of fossil remains of extinct animals contained in them.

In the "Philosophical Transactions" for 1817, 1821, and 1823, will be found some account of the earliest discoveries of these fossils, together with a record of carefully conducted observations by Sir Everard Home and Mr. Whidby (the engineer of the Breakwater at that time) respecting the circumstances under which they were met with.

Mr. Whidby, in a paper dated Nov. 1816, mentions the striking fact that he saw no possibility of the cavern in which the remains were met with having had any external communication through the rock in which it was enclosed, the surrounding limestone being everywhere equally strong, and requiring the same labour to blast it; and, with respect to the occurrence of stalactite, he remarks that nothing of the kind was met with in the cavern in which the bones were found, so that there is no proof that any opening in the rock from above had been closed by infiltration. In the year 1820 more bones were met with, lying on a thin bed of dry clay; there also occurred here and there a few small caverns, similar to that in which the bones were discovered; and again he states that none of them had the smallest appearance of ever having had any opening to the surface, or connection with it whatever, or with each other. The caverns here spoken of were quarried many feet below the bottom of them, and nothing was found but hard solid limestone. He also adds, "that many caverns have been met with in these quarries, the insides of which have been coated with stalactite; but there was no appearance of this kind in the cavern where the bones were found, every part of it being perfectly dry, and nearly clear of rubbish—a circumstance which clearly proves it had no connection with the surface."

During the summers of 1822-23, Mr. Jos. Cottle, of Bristol, obtained a large collection of bones from the same quarries, and he has published some account of them, and of the general circumstances of their occurrence.

Since that period, it would appear that similar openings in the limestone have been of not unfrequent occurrence, and it is known that some of them have contained fossils; but no systematic observations have, I believe, been instituted with the view of penetrating their origin or history.

The statements so confidently made by Mr. Whidby as to the perfect enclosure of the caverns by solid limestone, have been confirmed by my own observations, and this fact has not failed to surprize even the workmen engaged in the quarry; but it must be evident that at some period an opening did exist, and it occurred to me that such might be most successfully sought for between the surfaces of the beds of which the masses of limestone are composed. No satisfactory conclusion could be drawn from a careful examination of the rock

during the opening of the cavern; but, on looking narrowly at the beds of limestone in the progress of the workings, it was found that a thin seam of purple calcareous "slate" was interposed between the beds of limestone, at *about* the same parallel as that in which the caverns were met with. On further investigation, it was discovered that alternations of this purple "slate" with the limestone were not unfrequent, but the laminæ of slate were, in most cases, so intimately blended with the limestone-beds, as to form really a solid mass of compact rock; and on looking into the structure of the more evident layers of the "slate," it was ascertained that in some parts they were much more calcareous than in others, and that small portions of limestone, having similar physical characters to those of the surrounding rock, were interspersed at varying intervals. In other places the layers were in a state of decomposition, red and reddish white clay being formed as its result; and on tracing a layer of this kind through the side of a cavern laid open during the workings, it was seen that portions of it were so disintegrated as to be easily pulled from their position, the seam being, in its most solid portions, composed merely of layers of limestone-fragments with interposed clay and red sand—the whole, apparently, kept in place by the accidental infiltration of calcareous matter. Here, then, were facts that might enable me to account for the clay found in the caverns, and afford a means through which the beds of limestone may have been caused to separate from each other. Again, it was discovered that some of the hollows in the adjoining limestone were stained with a black earthy substance, found, on analysis, to be composed of the peroxides of iron and manganese, these having evidently proceeded from the decomposition of a variety of dolomite very generally present in this limestone—not exhibiting, however, any definite mode of deposit in it, but passing through its beds in the most irregular manner. From these phenomena, it appeared reasonable to conclude that the decomposition of the "slate" in the layers, through the combined agency of water and carbonic acid, had opened a communication with the external air to the above-named irregular masses of dolomite (the unchanged limestone-fragments of the "slate" serving to keep the beds from close contact with each other), and that in this way the carbonates of iron and manganese contained in them had been converted into peroxides, and the evolved carbonic acid proceeding from their decomposition, combining with the remaining constituents of the dolomite, had formed bicarbonates, readily removeable by the agency of percolating water. In this way it is possible, not merely to account for the formation of the caverns, and a means of access to them, but at the same time to discover what are the causes still in operation which give rise to the production of stalactite, and occasion the irregular dolomization of the limestone, it being evident that the percolating waters, charged with bicarbonates of lime, magnesia, &c., may, by a loss of carbonic acid, deposit insoluble carbonate of lime in the form of stalactite, and becoming by this means richer in bicarbonate of magnesia, act chemically on the neighbouring limestone, converting it into dolomite.

To test the correctness of these views, a very careful examination of the clay below the bones was instituted: it was extremely tenacious, and of a dark reddish-brown colour; patches of red clay were visible in some places, and in other parts of the mass distinct yellow and black layers were apparent, and nodules, or, more strictly speaking, irregular masses of impure ochry red iron-ore, together with black, rounded fragments, evidently arising from the decomposition of a dolomite similar to that before alluded to—for in the larger fragments this rock was distinctly visible on fracture, and in one or two instances, in which the masses were larger than usual, a brown zone was observable between the black external coating and the central nearly unaltered dolomite; large and small masses of the common limestone-rock of the quarry were also

found in the clay, their surface being honey-combed as if by exposure to the long-continued action of carbonated waters. These phenomena may justly be explained on the supposition, that the irregular masses of ochry iron-ore had been derived from the decomposed slaty seams, confirmatory appearances being not unfrequent in other limestone-beds connected with the same series of rocks, the "slate" in these alternating with the limestone on a large scale, and containing irregular nodules of impure iron-ore—a red oxide of iron being frequently visible at the points of junction. The varied colour of the clay may also be accounted for by the gradual admixture with it of the red oxide of iron from the slaty seams, and the black oxide of manganese, accompanied by yellow hydrated peroxide of iron from the dolomitic rock, which may be concluded to have formed a part only of the walls of the cavern—the honey-combed limestone fragments resulting from the displacement of other portions of previously fissured limestone-rock through the agency of aqueous carbonic acid. The most careful examination presented no facts that at all appeared of an opposing character; the clay was diligently searched, and some of its laminated portions, having a sandy appearance, were examined by the microscope for the siliceous coverings of infusoria, minute rounded grains of sand, and any other matter that might suggest the washing in of the contents of the cavern through free communication of its opening with external waters; nothing was, however, discovered but very minute fragments of slate, still further confirmatory of the position before advanced.

The facts elicited were thus far satisfactory, but they did not account for the original production of those masses of dolomite, which in the neighbourhood of the quarry, alone afforded, by their own decomposition, the solution of bicarbonates required for the dolomization of adjacent rocks: and in the hope that a knowledge of such original cause might throw still further light upon the present condition of the bone-caves, a general examination of the various accessible quarries of the Plymouth limestones was instituted.

I propose to give some account of these investigations in the latter part of this paper; and will now proceed to give a brief description of the fossil remains, and certain circumstances connected with them, as the following out of the inquiries alluded to will lead me to speak, not merely of changes having an important relation to the phenomena of the enclosed caverns, but also to the attempted solution of other allied geological questions of interest.

I am disposed to believe that very little stalactite was deposited in the bone-caves during the early period of their formation, and a portion, if not the whole, of the time during which the bones were being introduced. My reasons, confirmed by the observations of Mr. Whidby, before alluded to, are the following:—The bones have been generally found lying on or near the uppermost portion of a bed of clay, and those on its surface only are much mixed with, or imbedded in stalagmite, the remains met with lowest in the clay being especially free from such deposit. It is reasonable also to suppose that, if the fossil bones were introduced through the agency of carnivorous cave-inhabiting mammalia, the instincts of these creatures would have induced them to prefer a dry habitation, and one in which the constant dropping of percolating waters would give them no inconvenience, not to mention the constant disengagement of carbonic acid accompanying the deposition of the stalactite, which might even, under some circumstances, render such caverns uninhabitable.

In giving an opinion that the bones were introduced by animal agency, and not by accidental falling into fissures, it is not to be inferred that, in no former recorded instance, has this mode of entombment occurred. I will, however, give some facts connected with the nature and mode of occurrence of these remains, before attempting to deduce any further conclusions in the present instance.

In the first, I would mention that remains of very large animals were met with, the occurrence of portions of several mammoths being proved by the presence of various grinders belonging not merely to very young, but also to somewhat mature animals, a fourth molar of the lower jaw of an animal of this species having been found six and a-quarter inches in length, the breadth at its widest part being two and a-quarter inches, containing sixteen plates, which have all been brought into use, the tooth being worn down at its anterior extremity, so as to exhibit the common uniting base of dentine along the margins of the first and second plates. A second corresponding molar of the lower jaw wanting a few plates at its anterior portion, together with fragments of two other fourth molars in different stages of development were also met with, and teeth of larger size than these were indicated by the presence in the clay of other detached and fractured plates. I would also add that there occurred a few fractured portions of one or more molar teeth of the rhinoceros, but no mammoth's or other large bones were discovered.

The above facts being considered, can we allow that such ponderous animals could have fallen upon a soft tenacious bed of clay, without sinking more than a few inches into it? or that their skeletons could have been washed down from above, without a much greater disturbance of the clay than was found to be indicated by the parallel and undisturbed arrangement of its laminated portions? Could, moreover, these monsters have fallen into the cavern, without a much greater apparent disturbance of the beds of limestone having been caused by the formation of a sufficiently large opening; and would not, in such cases, numerous other parts of the skeleton have been met with?

Secondly, numerous teeth of elk or deer and of ox were found, but no antlers nor horn-cores belonging to such animals (a single fragment of the base of an antler and one small horn-core excepted), which would, most probably, have been the case, had the fissure been a large one, and some fragments, at least, of the fragile antlers might naturally have been expected to occur, had such been washed down from a higher level; on the other hand, it may be presumed that they would have proved to carnivora an inconvenient and unprofitable burthen for carriage into their den.

Thirdly, among the bones met with, scarcely a single large one had escaped fracture, with the exception of the astralagus and other hard and solid bones of the tarsus and carpus joints and those of the feet; facts perfectly similar to those observed by Dr. Buckland in the hyæna-cave at Kirkdale, in which the presence of their numerous coprolites proved that these animals inhabited the cavern.

Fourthly, although the cave did not contain any remains of hyænas or their coprolites, several teeth of bears and lions or tigers were discovered; and I think it may be legitimately deduced from the occurrence of these cave-inhabiting animals that the bones above referred to had been fractured by them for the purpose of obtaining their edible contents; the occurrence of several fragments of canines of the gigantic *Felis spelæa* having the two characteristic longitudinal indentations on their crowns, together with the canine and sectorial molar of an immense lion or tiger, the former tooth measuring five and three-quarter inches in length, may too, I imagine, satisfactorily account for the strength required to carry the remains of such animals as the mammoth and rhinoceros into the cave.

Lastly, I would remark that the view of the non-accidental introduction of the remains into the cave appeared still further to be confirmed by the appearances presented in a fissure unexpectedly opened into by the workmen, and separated from the larger cavern by a comparatively thin wall of solid limestone. Here many of the bones were only slightly fractured, and there occurred the nearly perfect skull of a hog, encrusted with stalactite, a cast in the same sub-

stance of the interior of the cranium of another animal, together with remains, apparently belonging to the bear, wolf, or large dog, and the horse, with various other fractured bones cemented into a breccia-like mass by a mixture of clay and stalactite. These appearances coincide with what might have been expected to have occurred in the case of bones that had accidentally fallen into a fissure, and it is not unlikely that they may have been rolled into it through a small deep hole communicating with the large cavern, but not sufficiently capacious to allow of entrance for the recovery of the carcass. The brecciated bones in the clayey stalactite might have been also derived from the larger cave by the constant falling into it of fragments of bone rejected by the carnivora, and which, as might be expected from lying for some time in their den, would be well mixed with the clay that formed its bottom.

A few of the bones were traversed in all directions by fissures filled with clayey stalagmite, a mass composed of broken plates of a tooth of the mammoth being in this condition—these facts possibly indicating displacement of the walls of the cave after the introduction of the bones, such dislocation affording the opening, by means of which the superficial stalagmite was introduced.

In concluding this part of my description of the caverns and their inhabitants, I will enumerate the genera of animals to which the specimens (nearly all of which are in my own possession) belong.

(To be continued.)

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—November 30, 1859.—Professor John Phillips, President, in the Chair.

The following communications were read:—

1, "On some Bronze Relics from an Auriferous Sand in Siberia." By T. W. Atkinson, Esq., F.G.S.

During the author's stay at the gold-mine on the River Shargan (Lat. 59 deg. 30 min. N., and Long. 96 deg. 10 min. E.) in August, 1851, some fragments of worked bronze were dug up by the workmen, at a depth of fourteen feet eight inches below the surface, from a bed of sand in which gold-nuggets occur. This sand rests on the rock, and is covered by beds of gravel and sand, overlain by two feet of vegetable soil. The fragments appear to have belonged either to a bracelet or to some horse-trappings.

2. "On the Volcanic Country of Auckland, New Zealand." By Charles Heaphy, Esq. Communicated by the President.

The isthmus-like district of Auckland and its neighbourhood, described by Mr. Heaphy as a basin of Tertiary deposits, is bordered by clay-slate, igneous rocks, and at one spot on the south by cretaceous strata; and it is dotted by upwards of sixty extinct volcanos, often closely situated, and showing in nearly every instance a well-defined point of eruption, generally a cup-like crater, on a hill about three hundred feet high. Interesting instances of successive volcanic eruption are numerous all over this district, sixty miles round Auckland; and there seems to have been four distinct epochs of eruption, thus classified by Mr. Heaphy:—1. The first was that which raised the trachytic

mountains and the black boulder-like igneous rock. 2. Then came the eruptions in the Tertiary period, the ashes of which form beds in the Tertiary rock. 3. Then the eruptions on the upheaval of the Tertiary cliffs: these appear as cones above faults on the Tertiary beds and on the edges of cliffs. 4. Lastly the eruptions that have broken through the Tertiary beds, and the lava-streams of which follow the natural valleys of the country. The volcanic phenomena were illustrated by maps and numerous sketches by the author. Some Tertiary *Terebratulæ*, some few fossil plants, and some Cretaceous fossils (*Inoceramus* and *Belemnitella*) accompanied this memoir.

3. "On the Geology of a part of South Australia." By T. Burr, Esq. From the Colonial Office. 1848.

The lowlands about Adelaide on the west, and along the river Murray on the east, consist of horizontal beds of limestone and calcareo-siliceous deposits, yellowish and reddish in colour, full of marine fossils, and of the Tertiary age. Sometimes gypsum and ferruginous sand replace the limestone. These plains are arid, except where granite protrudes from the surface, presenting cavities in which rain-water collects. The author observed a similar Tertiary formation on Yorke's Peninsula, at Port Lincoln, and to the S.E. to beyond Rivoli Bay; and it probably forms vast tracts in New South Wales and Western Australia. None of these tertiary districts appear to exceed an elevation of three hundred feet above the sea.

In describing two volcanos in South Australia, Mount Gambier and Mount Schauck, Mr. Burr remarked that, coming from the west or north-west at about twenty miles from these hills a white coral-limestone (Bryozoan limestone), containing flint or chert, takes the place of the limestones and calcareous sandstones, with recent sand-formations, previously passed over. This white limestone is remarkable for the numerous deep well-like water-holes in it, within about twelve miles of the volcanic mountains, and about east or west of them.

Mount Gambier has a height of nine hundred feet above the sea (six hundred feet above the plain), and has three craters, lying nearly east and west, and occupied with lakes of fresh-water. Mount Schauck, at a distance of about nine miles, magnetic south, is circular, and has one large, and two small lateral craters.

The author next described the granite, gneiss, and slaty rocks along a section extending from the River Murray and Kangaroo Range, across Mount Barker and Mount Lofty, towards Adelaide; and noticed the mode of occurrence of the ores of copper, iron, lead, &c., in these rocks. Lastly he noticed and explained the occurrence of calcified stems of trees, standing in the position of their growth, in the sand-dunes in the Gulf of St. Vincent, near Adelaide.

4. "On some Tertiary deposits in South Australia." By the Rev. Julian Edmund Woods. Communicated by the President.

The author, in the first place, described the geographical features of that part of the colony of South Australia to which his observations refer. It lies between the River Murray on the west, and the colony of Victoria on the east; and includes an area of one hundred and fifty-six miles long, north and south, and seventy broad from east to west. Some trap-dykes and four volcanic hills are almost the only interruptions to the horizontality of these plains, which rise gradually from the sea, and are occupied by the Tertiary beds to be noticed; they extend into Victoria for some seventy miles, as far as Port Fairy.

In some places on the plains a white compact unfossiliferous limestone lies under the surface-soil; and is sometimes thirty-feet thick. Under this is a fossiliferous limestone. The passage between the two is gradual. This latter

rock is made up of *Bryozoa*—perfect and in fragments—with some *Pectens*, *Terebratulæ*, *Echinoderms*, &c.

Sometimes this rock appears like friable chalk, without distinct fossils. A large natural pit, originating from the infalling of a cave, occurs near the extinct volcano, Mount Gambier, and is ninety feet deep, showing a considerable thickness of this Bryozoan deposit in several beds of fourteen feet, ten feet, and twelve feet in thickness. Similar pits show the deposit in the same way at the Mosquito Plains, seventy miles north.

Regular layers of flints, usually black, rarely white, occur in these beds, from fourteen to twenty feet apart. These, with its colour, and with the superficial sand-pipes, perforating the rock to a great depth, give it a great resemblance to chalk.

The whole district is honeycombed with caves—always, however, in the higher grounds in the undulations of the plains.

One of the caves, in a ridge on the northern side of the Mosquito Plains, is two hundred feet long, is divided into three great halls, and has extensive side-chambers. The caves have a north and south direction, like that of the ridge. The large cave has a great stalactite in it; and many bones of Marsupialia are heaped up against this on the side facing the entrance; possibly they may have been washed up against this barrier by an inflowing stream. The dried corpse of a native lies in this cave. It has been partially entangled in the stalactite; but this man was known to have crept into the cave when he had been wounded, some fourteen years ago. Many of the caves have great pits for their external apertures, and contain much water.

Some shallow caves contain bones of existing Marsupialia, which have evidently been the relics of animals that fell into the grass-hidden aperture at top.

The caves appear in many caves to be connected with a subterranean system of drainage; currents and periodical oscillations being occasionally observed in the waters contained in them. There is but little superficial drainage. One overflowing swamp was found by the author to send its water into an underground channel in a ridge of limestone.

Patches of shelly sand occur here and there over the ten thousand nine hundred and eighty square miles of country occupied by the white limestones; but near the coast this shelly sand thickens to two hundred feet.

A coarse limestone forms a ridge along the coast-line, and it contains existing species of shells. This indicates an elevation of the coast of late date, and which probably is still taking place.

Dec. 14.—1. "On some Remains of *Polyptychodon* from Dorking." By Prof. Owen, F.R.S., F.G.S.

Referring to the genus of Saurians which he had founded in 1841 on certain large detached teeth from the Cretaceous beds of Kent and Sussex, and which genus, in reference to the many-ridged or folded character of the enamel of those teeth, he had proposed to call *Polyptychodon*, Prof. Owen noticed the successive discoveries of portions of jaws, one showing the thecodont implantation of those teeth, which, with the shape and proportions of the teeth, led him to suspect the crocodilian affinities of *Polyptochodon;* and the subsequent discovery of bones in a Lower Greensand quarry at Hythe, which, on the hypothesis of their having belonged to *Polyptychodon*, had led him to suspect that the genus conformed to the Plesiosauroid type.

The fossils now exhibited by Mr. G. Cubitt of Denbies, consisted of part of the cranium (showing a large foramen parietale), fragments of the upper and lower jaws, and teeth of the *Polyptychodon interruptus*, from the Lower Chalk of Dorking, and afforded further evidence of the plesiosauroid affinities of the genus. Professor Owen remarked that in a collection of fossils from the Upper

Greensand near Cambridge, now in the Woodwardian Museum, and in another collection of fossils from the Greensand beds near Kursk in Russia, submitted to the Professor's examination by Col. Kiprianoff, there are teeth of *Polyptychodon*, associated with plesiosauroid vertebræ of the same proportional magnitude, and with portions of large limb-bones, without medullary cavity, and of plesiosauroid shape.

Thus the evidence at present obtained respecting this huge, but hitherto problematical, carnivorous Saurian of the Cretaceous period seemed to prove it to be a marine one, more closely adhering to the prevailing type of the Sea-lizards of the great mesozoic epoch, then drawing to its close, than to the *Mosasaurus* of the Upper Chalk, which, by its vertebral, palatal, and dental characters, seemed to foreshadow the Saurian type to follow.

Professor Owen exhibited also drawings of specimens in the Woodwardian Museum and in the collection of Mr. W. Harris, of Charing, which show the mode and degree of use or abrasion to which the teeth of *Polyptychodon* had been subject.

2. "On some Fossils from near Bahia, South America." By S. Allport, Esq. Communicated by Professor Morris, F.G.S.

The south-west point of the hill on which the Fort of Montserrate is built, in Bahia Bay, exhibits a section of alternating beds of conglomerate, sandstone, and shale; in the last Mr. Allport discovered a large Dinosaurian dorsal vertebra, not unlike that of *Megalosaurus*, several Crocodilian teeth, and numerous large scales of *Lepidotus*, together with a few Molluscs (*Paludina*, *Unio*, &c.), some *Entomostraca*, and Lignite. Two miles from Montserrate, in a N.E. direction, is the Plantaforma, another hill of the same formation, but loftier. The shales here also yielded similar fossils.

These fossiliferous shales and conglomerates dip to the N.W. towards the Bay, and appear to overlie a similarly inclined whitish sandstone, which rests against the gneissose hills ranging north-easterly from the point of St. Antonio.

3. "On a Terrestrial Mollusc, a Chilognathous Myriapod, and some new species of Reptiles, from the Coal-formatian of Nova Scotia." By J. W. Dawson, L.L.D., F.G.S., &c.

On revisiting the South Joggings in the past summer, Dr. Dawson had the opportunity of examining the interior of another erect tree in the same bed which had afforded the fossil stump from which the remains of *Dendrerpeton Acadianum* and other terrestrial animals were obtained in 1851 by Sir C. Lyell and himself. This second trunk was about fifteen inches in diameter, and was much more richly stored with animal remains than that previously met with. There were here numerous specimens of the land-shell found in the tree previously discovered in this bed—several individuals of an articulated animal, probably a Myriapod—portions of two skeletons of *Dendrerpeton*—and seven small skeletons belonging to another Reptilian genus, and probably to three species.

The bottom of the trunk was floored with a thin layer of carbonized bark. On this was a bed of fragments of mineral charcoal (having Sigillaroid cell-structure), an inch thick, with a few Reptilian bones and a *Sternbergia*-cast. Above this, the trunk was occupied, to a height of about six inches, with a hard black laminated material, consisting of fine sand and carbonized vegetable matter, cemented by carbonate of lime. In this occurred most of the animal remains, with coprolites, and with leaves of *Noeggerathia (Poacites)*, *Carpolithes*, and *Calamites*, also many small pieces of mineral charcoal, showing the structures of *Lepidodendron*, *Stigmaria*, and the leaf-stalks of Ferns. The upper part of this carbonaceous mass alternated with fine grey sandstone, which filled the remainder of the trunk as far as seen. The author remarked that this tree, like other erect *Sigillariæ* in this section, became hollow by decay,

after having been more or less buried in sediment; but that, unlike most others, it remained hollow for some time in the soil of a forest, receiving small quantities of earthy and vegetable matter, falling into it, or washed in by rains. In this state it was probably a place of residence for the snails and myriapods and a trap and tomb for the reptiles; though the presence of coprolitic matter would seem to show that in some instances at least the latter could exist for a time in their underground prison. The occurrence of so many skeletons, with a hundred or more specimens of land-snails and myriapods, in a cylinder only fifteen inches in diameter proves that these creatures were by no means rare in the coal-forests; and the conditions of the tree with its air-breathing inhabitants implies that the Sigillarian forests were not so low and wet as we are apt to imagine.

The little land-shell, specimens of which with the mouth entire have now occurred to the author, is named by him *Pupa vetusta*. Dr. Dawson found entire shells of *Physa heterostropha* in the stomach of *Menobranchus lateralis*, and hence he supposes that the *Pupæ* may have been the food of the little reptiles, the remains of which are associated with them.

Two examples of *Spirorbis carbonarius* also occurred; these may have been drifted into the hollow trunk whilst they were adherent to vegetable fragments. The Myriapod is named *Xylobius Sigillariæ*, and regarded as being allied to *Iulus*.

The reptilian bones, scutes, and teeth referable to *Dendrerpeton Acadianum* bear out the supposition of its Labyrinthodont affinities. Those of the new genus, *Hylonomus*, established by Dr. Dawson on the other reptilian remains, indicate a type remote from *Archegosaurus* and *Labyrinthodon*, but in many respects approaching the Lacertians. The three species determined by the author are named *H. Lyellii, H. aciedentatus*, and *H. Wymani*.

4. "On the Occurrence of Footsteps of *Chirotherium* in the Upper Keuper of Warwickshire." By the Rev. P. B. Brodie, F.G.S.

True Chirotherian feetsteps do not appear to have been hitherto met with in the Keuper of Warwickshire; but a specimen of Keuper sandstone showing the casts of a fore- and a hind-foot of Chirotherium was lately turned up by the plough at Whitley Green, near Henley-in-Arden. The breadth of the fore-foot is about two inches, the hind-foot is four and a-half inches across. As the New Red sandstone of Cheshire, so well known for its fine Chirotherian foot-tracts, certainly belongs to the upper part of the New Red series, it may now be further correlated with the Upper Keuper of Warwickshire, the latter having yielded true Chirotherian foot-prints.

Geologist's Association, Ordinary Meeting, 5th Dec., 1859. Rev. Thomas Wiltshire, M.A., F.G.S., President, in the chair.

The president stated that since the last meeting the Association had lost a valuable friend in the person of John Brown, Esq., F.G.S., who had prepared a paper which was to have been read that evening. Under these circumstances the committee had thought it respectful to the memory of Mr. John Brown, that his paper (which had been forwarded to the president) should not be read until the next meeting in January. It was announced that Professor Tennant, F.G.S., had kindly volunteered at very short notice to give a lecture on siliceous nodules in the various formations.

Professor Tennant commenced by some observations on the large proportion in which silica enters into the composition of rocks, constituting one-half part of granite, one-third part of syenite, nine-tenths of quartz, and three-fourths of greensand. He then described the enormous amount of silica in the flints of the upper chalk, and called attention to the peculiarity which distinguishes the beds of flints in Kent and Sussex from those of Yorkshire. In the former they

are of dense structure; in the latter mostly of a porous character, taking regular forms, not unlike those of many modern sponges.

Some remarks were then made on Dr. Bowerbank's theory that the great mass of the flints found in the chalk are true sponges: a theory to which Professor Tennant said he was inclined to subscribe. He pointed out as an illustration of its possible truth, and as a proof that organic remains may be enclosed in silica, the well known appearance of moss-agates, sections of which, procured from Oberstein, cannot under the microscope be distinguished from sections of certain modern sponges. Professor Tennant also drew attention to the difference in the flints of volcanic and aqueous rocks; the former being destitute of, whilst the latter abound in, organic remains.

After alluding to the beds of chert in many of the formations, such as the Portland-rock, Greensand, etc., he advocated the view that the Paramoudra, of Ireland, are nothing more than enormous silicified sponges, and concluded with an account of the hollow flints found on Salisbury Plain, the core of which when examined under the microscope is seen to be composed of a mass of delicate spicules.

A discussion by several of the members followed, during which the president directed attention to a circumstance, which Mr. Charlesworth confirmed, viz., that a mass of flint when surrounding the base of a ventriculite, never envelopes the whole of the root of the ventriculite.

Mr. Charlesworth made several remarks, with a view of explaining this phenomenon, and at some length entered into reasons for disagreeing with the views of Dr. Bowerbank as to the spongous origin of many of the Chalk flints.

The late Mr. John Brown, F.G.S., of Stanway, has bequeathed the sum of £100 to the Association.

Malvern Field Club.—The Naturalists' Field Club lately held a meeting at Pershore, on which occasion the President, the Rev. Mr. Symonds, of Pendock, addressed the meeting at some length upon a few of the most important scientific topics of the day. On the subject of the supposed flint implements which have caused so much disquisition among geologists, Mr. Symonds remarked that they were discovered in the north of France, in undisturbed beds of gravel, sand, and clay, in drift, in fact, of much the same geological age as the old lake- and river- margins of the Avon, the Severn, and the Wye. The level of the land in that part of France, however, appears to have been more deranged by oscillating movements than has been the water-level of the peaceful vales of Worcestershire and Herefordshire. The stratified gravel, containing the weapon-looking flints, associated with the remains of the extinct elephant and rhinoceros, occupies, in some localities, a height of one hundred feet above the present level of the river Somme, which has worn for itself a newer and deeper bed since those flints and the bones of wild beasts were buried together in the mud, silt, and gravel of its ancient margins. On the question of the human fabrication of the flints, Mr. Symonds said that he had seen many exhibited at Aberdeen, by Sir Charles Lyell and Mr. R. W. Mylne, and that the rudeness of many of these implements might well cause the cautious investigator of truth to pause before he believed that they were wrought by men; while on the other hand some of the specimens appeared to have been so wrought. The question rested, from the evidence Mr. Symonds could collect, on the fact as to whether or not the flints were human implements. The remains of the extinct mammalia may have been drifted from older beds, but the physical geology of the district, and the physical position of the stratified drifts, containing the supposed human implements, compelled the most able of the geologists of France and England to arrive at the conclusion that, if these flints

are human implements, man lived at a far more remote epoch than has usually been assigned to his creation.

The Pteraspis discovered at Leintwardine, near Ludlow, by Mr. Lightbody, of the Woolhope Club, in the Lower Ludlow deposits, greatly antedated the period at which fish were supposed to have first existed. The fossil had been examined by competent authorities and both its fish character, and the physical position of the beds, had now been firmly established. After the meeting of the British Association of Aberdeen, Mr. Symonds accompanied Lord Enniskillen, Sir C. Lyell, Sir W. Jardine, and Professor Harkness to the Elgin district, for the further examination of the reptile-bearing sandstones containing the Telerpeton, Stagonolepis, and Hyperadaphodon, and long supposed to belong to the age of the Old Red Sandstone. Mr. Symonds entirely agreed with the opinion formed by Sir C. Lyell, founded on a mass of evidence and details too intricate to be briefly or easily explained, that the reptiliferous sandstones of Elgin are more probably of the Triassic age, than of the epoch of the Old Red.

NOTES AND QUERIES.

Notices of Incorrectnesses in Mr. Page's Handbook of Geological Terms.—Dear Sir,—On the recommendation of last month's "Geologist," I bought Mr. Page's Handbook of Geological Terms. Upon glancing at it, I saw that he had fallen into some errors of pronunciation, and, invited to do so by his preface, I wrote to him immediately to put him on his guard, and give him an opportunity of taking such steps as he should deem advisable. As the matter seems to have escaped your notice, I think it well to advise you of it. In my opinion there are many of these errors; but others may differ from me in some instances. I note a few, however, below, which admit of no doubt, as reference to every lexicon and received authority will show:

Affínis, Agglútinans, Albe-galérus, Briaréus, Cóncavus, Cóngeners, Echínus and Echínite, Edúlis, Eúglyphus, Gigantéus, Hexagónus, Hippocrépis, Macrospóndylus, Mammillíferous.

One or two other errors of a different kind, have caught my eye.

Miliola he derives from mille—though confounding the idea with that of μυριάς, 10,000, apparently. It evidently comes from milium, the seed of millet, which the little shell resembles.* It would have been milliola otherwise, I suppose, for the inventor would hardly have chosen the obsolete mile for such a purpose.

Siva is a male deity, not a goddess.

Brachiopoda—"spiral arms," "which they can uncoil and protrude."

Woodward says, "It has been conjectured, etc. . . this supposition is rendered less probable by the fact that, in many genera, they are supported by a brittle skeleton of shell"—Manual, p. 211.—I am, dear sir, yours truly, Henry Eley.—We regard Mr. Eley's communication as a most important note, and we cordially introduce it, as expressive of our sincere wish to add to the usefulness of Mr. Page's valuable book, to remove some more of the numerous stumbling blocks already laid in the student's path by the bad Latinism of very many of the modern naturalists and palæontologists. There is not only a

* If crowded aggregation is implied, the spike of millet is a most apt similitude.

want of a critical guide for the unlettered student, but the faulty pronunciation in vogue seems little likely to be corrected without a good standard of reference more ready at hand than dictionary and gradus. We may remark that, besides those instances mentioned by Mr. Eley, several of which, especially affínis, giganténs, cóncavus, edúlis, are sldom rightly spoken among geologists, there is the frequent mispronunciation of such words as the genetives of proper names; thus, Mílleri wrongly for Milléri, Scóuleri for Scouléri, and the like; also Ganoidéa, Crinoidéa, Cystidéa, &c., are not always thus correctly pronounced. We may, however, remind tyros that family names, such as Ostréidæ, are to be pronounced as Mr. Page thus marks, not Ostreídæ, as it is incorrectly and too commonly spoken.

In Mr. Page's list at p. 40, multifidus has no accentuation, it should be multifídus—too often pronounced multífidus wrongly; so also quadrifídus and trifídus. Hemisphericus (p. 398) should be hemisphæricus. Fossilis (p. 396) should be accentuated fossílis. Cervical at p. 111 should be Cervícal, not Cérvical.

We here add some other corrections which have been pointed out to us by another correspondent, and we hope the book will be all the better for such criticisms in the next edition. For its sake we are open to receive more notes of corrections, so that both tyro and Mr. Page may have the benefit thereof. Digitalus, finger-like, should be either digitalis, belonging to a finger, or digitatus, fingered—formed as fingers; dorsalis should have its accent on the middle syllable; gagateus may be accented thus, gagáteus. In the Latin, König should be spelt Koenigius; so also Noeggerathius. Longímanus wants the accent at p. 401. The correction of psilópora for the incorrect psilopóra (p. 409), and tubípora for tubipóra, may remind many of the common wrong pronuncation of the multitude of names of corals and bryozoa partly composed of pora, a pore. Pygmæus, unaccented at p. 409, should have its penultimate syllable long; this is often forgotten. In the same page, pucillus is apparently a misprint for pusillus, and Rankinei for Rankinéi. Saxátilis at p. 410 should be Saxatílis. Toliapicus (p. 414) has, we believe, a reference to Tolapia, or some similar form of the Latin name of the Isle of Sheppy. Unícolor should take the place of the incorrect unicólor. Mæandrinus should be placed for meandrinus, Macróstomus for macrostómus. Moniliformis and monilitectus monileformis, etc. Muensterianus for Münsterianus (after Count Münster). Cypridina-Schiefer (p. 137) should not be half Latin half German, but as the Germans have it, Cypridinen-Schiefer.

We would suggest that the description of Brachiopoda at page 96, may be corrected thus:—"which they cannot uncoil and protrude, but with which" etc.

SLICKENSIDES.—DEAR SIR,—I was much interested by the queries and replies, upon the subject of slickensides, in the last number of the "GEOLOGIST." They are very abundant in the Keuper sandstone of Cheshire, and the south-west of Lancashire. Usually, two polished striated surfaces exist together, but not always, for occasionally a single slickenside is only opposed by a soft sandstone, without any trace of such an appearance. Those said to be two feet apart, I think can have no connection with each other. Faults are very numerous in this neighbourhood; in width they vary from an inch to twenty yards. They are always filled with sandstone, very much harder than the strata bounding them, while at each side slickensides abound. If the strata at each side of the fault is removed, the enclosed compact rock stands across like a wall, beautifully polished and striated upon each side. In such cases it is evident that the polished surfaces could not have been caused by the original disruption of the strata, but afterwards—long after the fault had been filled by debris. I am therefore of opinion that a throw of the strata to a very small extent, acting under immense pressure, was sufficient to cause the phenomena.

This is confirmed by the occurrence of slickensides at different angles in slides of the rock within the faults, and also by highly polished surfaces, occurring in very slight faults, which displace the strata only a foot or eighteen inches.

I believe it is the compact sandstone within the faults, and not the slickensides, that is considered to act as a barrier to subterranean water.—I remain, dear sir, yours etc., GEORGE HILLOSTON, F.G.S., Liverpool.

SLICKENSIDES.—DEAR SIR,—The subject of "slickensides" is one to which I have paid some attention, and I have always noted as many of the facts relating to this appearance on rock-surfaces as I possibly could. I have read with much interest in the last number of the "GEOLOGIST" the queries on "slickensides" submitted to the Geological Section of the British Association during the meeting at Aberdeen, by Mr. Price, and the replies by Professor Ansted. Permit me to offer a few remarks on this really curious and interesting subject.

The formation of a "slickenside" on any rock-surface is due to the sliding of one rock-mass on the other, the motion very possibly having been a slow one, but exerted under enormous pressure, and without the aid of more heat than would have been produced by the friction. The result of this motion would, in the first instance, be the pulverization more or less of the two opposing rock-surfaces, and when this crushing action ceased, the re-consolidation of that crushed material, by means of enormous pressure, accompanied by motion.

I find in limestones and sandstones that most usually the "slickenside-" striæ are on the surface of the beds, and their direction frequently parallel to that of the dip. In my geological notes I find many references like the following: "Slickensides-striæ parallel to the dip of the beds, showing vertical displacement in the mass;" but when the striæ are transverse to the dip, and in the direction of the strike of the beds, I say that "horizontal displacement is indicated." In either instance of course there is no *fault* produced in the strata, though a displacement of them *en masse* is clearly indicated, the direction of which being pointed out by that of the striæ of compression. This is the only way in which rock-masses can be displaced without being faulted.

The slickenside-striæ are frequently oblique to the dip of the beds, the angle of obliquity being of course variable, but always indicating the direction of the displacement.

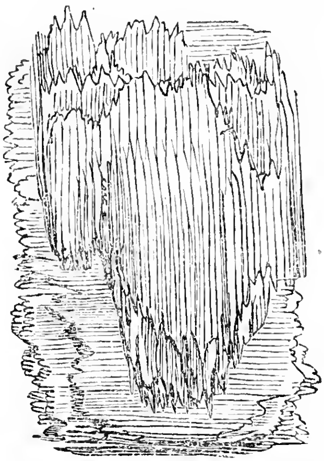
The thickness of the slickenside, or striated substance, is very variable; sometimes it is as thin as card-paper, at others nearly an inch from one surface to the other. It varies also in its internal structure: sometimes it consists throughout of a series of very thin and finely striated lamellæ, which readily flake off from each other by the application of a penknife, or when struck on the fractured edges with the hammer. At other times this structure is only partial, and confined to the surfaces; and again, when the slickenside is tolerably thick, it is homogeneous throughout, the surfaces above presenting a highly-polished or glazed appearance, but not such as would be the result of vitrification.

In limestones the slickenside frequently appears as a white calcareous material resembling opaque carbonate of lime, but coated with a carbonaceous-looking glaze, which readily soils the fingers. In slate or sandstone-rocks the slickenside is most usually homogeneous in its structure; it comes away in small slabs, and resembles dull-looking quartz, or quartzite, having both surfaces highly polished, beautifully and often deeply striated, and stained of a dark manganese— brown, or black colour.

The most remarkable kind of slickenside I know of is one not unfrequent in the carboniferous limestone of Ireland; it exhibits two distinct sets of striæ,

arranged more or less at right angles to each other, and closely adhering, one set being parallel, or nearly so, to the dip, and the other to the strike of the beds.

From this it would appear that the beds above and below had two distinct motions given to them, but at different intervals of time. In the example before us we have evidence for believing that at first one set of beds moved while the other remained stationary; and that one half of the crushed intervening substance, while adhering to the moving mass by cohesion was pulled into a state of striation to the amount of only one-half its thickness. The motion then suddenly ceased, and the adjoining beds were moved, but in a direction directly contrary to the first. The remaining portion of the pulverized material followed this second impulse, and assumed a striated structure, the lines of which were parallel with the direction of the displacement and consequently at an opposite angle with that which was first formed.



Fragment of "Slickenside," exhibiting two sets of striæ (full size).

We have in Brockedon's patent pencils a familar example of the reconsolidation of a powdered substance by the application of enormous pressure into a material harder and more free from grit, or other impurities, than the original native plumbago, and to this our slickensides bear a striking analogy. Dear sir, faithfully yours, Geo. V. Du Noyer, M.R.I.A., Geological Survey of Ireland.

Published Accounts of Fossil Human Remains.—Sir,—Will you oblige me by answering the following query in the "Geologist." I ask as well for others as myself. Where may be procured the fullest and most reliable information respecting fossil human remains that have been discovered in the world? Subscriber, Redlands.—There is no connected account of the human remains discovered in various parts of the globe, and it is one of the objects of the papers on the "First Traces of Man on the Globe." now publishing in this magazine, to give a collected account of all the reliable cases, and to give illustrations of the ancient flint-weapons, etc., as also of the stone-implements recently, or still in use amongst savage tribes in various parts of the world.

The best account of human remains published up to the present time will be found in the appendix to M. Boucher de Perthes' book. Other notices may be profitably consulted, such as Dr. Mantell's paper, read at the Oxford meeting of the Archæological Institute, 1850, and M. Marcelde Serres' several papers in the Bulletin Soc. Geol. de France, Comptes Rendus, etc.

Deposition of Warp.—Sir,—In "Notes and Queries," in the "Geologist" for December last, W. Nottingham asks two questions, viz., 1st. Where does the warp come from? 2nd., How is it that the Humber and its tributaries—the Trent, Ouse, Don, etc., are the only rivers in Great Britain that deposit "warp"?

When we take into consideration the fact that the Humber receives the

drainage of nine thousand one hundred and seventy three square miles, of which the Trent alone draws from four thousand five hundred square miles, the remaining four thousand six hundred and seventy-three square miles supplying the Ouse, we may form some idea where part of the "warp" comes from. What proportion river-sediment from floods, etc., may supply, I cannot pretend to say. Then we have the gradual wearing away of our Yorkshire coasts from two miles east of Bridlington Quay to Spurnt Point, which is a distance of about forty-three miles. Along this coast we lose, on an average, six feet three inches annually. In fact new roads have continually to be made in consequence of the sea making such rapid encroachments on the land, which, when washed away, is taken up the Humber and constitutes another source from which the "warp" is formed, and deposited upon lands up the rivers, etc.

I think your correspondent, W. Nottingham, will be able to draw from these facts answers to both his questions. I believe that no other river, or rivers in England are situated under such favourable circumstances for making the deposits called "warp" as are the rivers above mentioned.—Dear sir, yours faithfully, EDWARD TINDALL.

REVIEW.

Mr. Tennant's Mineralogical and Geological Collections.

We have received specimen cases of the two hundred, and three hundred selected examples of fossils and minerals, accompanied by the very useful catalogue of ordinary British fossils, recently published by Mr. Tennant. These collections are designed as an initiary means of instruction for students and tyros. Nothing so much tends to facilitate and encourage the study of any science as a ready means of access to the principal objects referred to in the general descriptions and writings of authors. It is easy to accumulate specimens of rocks and fossils, and to form expensive collections; but it is not so easy to form a limited and proper selection which shall at once illustrate the chief facts of a science, and be of real service to the student.

Professor Tennant's well known intimate knowledge of minerals gives confidence to learners as to the correctness of the naming of the specimens, and his long experience in this class of rudimentary collections—first made by his immediate predecessor, Mr. Mawe, more than fifty years ago—shows itself in the completeness and perfection of the present cabinet collections, in which, although the samples of fossils and minerals are of small size they are typically characteristic, and have every scientific advantage of displaying sufficiently their characters with that essential one of condensed space. The cabinets in which the collections are contained are strongly and neatly made, and, whether as useful and interesting presents at this season of gifts, or viewed in their proper light of aids to the comprehension of elementary treatises on Geology or Mineralogy, they are well worthy of the recommendations given to them by Sir Charles Lyell, the late Dr. Mantell, and other eminent geologists, and in which we readily concur.

THE GEOLOGIST.

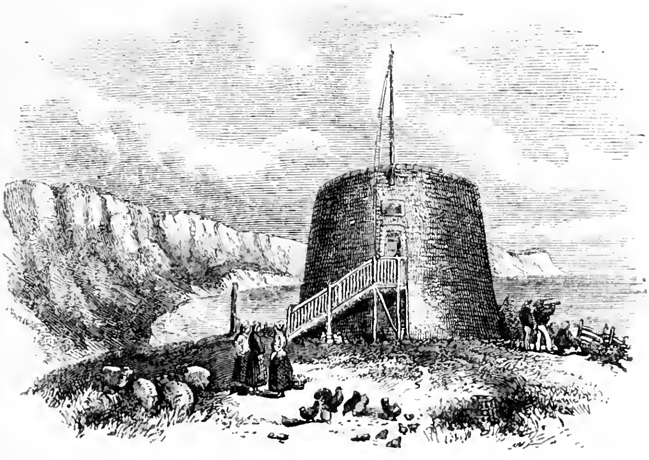
FEBRUARY, 1860.

GEOLOGICAL LOCALITIES.—NO. I.

FOLKESTONE.

By S. J. Mackie, F.G.S., F.S.A.

Time passes away, and we all of us grow older and older. As day by day the daylight lengthens or contracts, the air gets warmer or chillier, the skies brighter or bleaker, and everything around us imperceptably changes, it is only after the lapse of weeks that we perceive the change.



Lign. 1.—Eastwear Bay, from Copt Point.

Yet Time never stays his rapid course; and in mid-life it is perhaps for the first time we stop in our onward path to feel, for the first time too, we are not what we were.

Years ago, when a child, I picked up shells and pebbles on the Kentish strands. In school-boy days, with bolder hand and surer foot, oft have I scrambled o'er those white chalk-cliffs, or clambered homewards for six long miles o'er sea-weeded rocks with satchel loaded full of fossils gathered from the slippery shores of Eastwear Bay, were the dark-blue crumbling Gault daily yields its crop of glittering fossils to the destructive battering of the salt sea waves.

As the home almost of my childhood do I still look back to Eastwear Bay. On its flat and sanded shores are dotted innumerable earth coils of ever-working worms, o'er the bronzed and unctuous fields of tangle and fucoids, and the barnacle-crusted rocks are spattered myriads of tiny tube-worms (Spirorbes and Serpulæ), and thousands of patches of the matted and netted towns of bryozoans (Escharæ and Flustræ). The rough waves wash up the almost senseless bristled sea-mouse (*Aphrodita aculeata*). Perriwinkles cling to the overlapping algals, and troups of limpets at the recess of the tide march down with solemn step and slow to browse in the fields of the serrated fuci, retiring before its flood to fit themselves fastidiously down again to their perches on the rocks. Lobsters and crabs pass seemingly happy days in holes amongst the bigger stones, while eolids, dorids, and other inhabitants of the deep wade here ashore o'er smooth, or rugged paths to spawn.

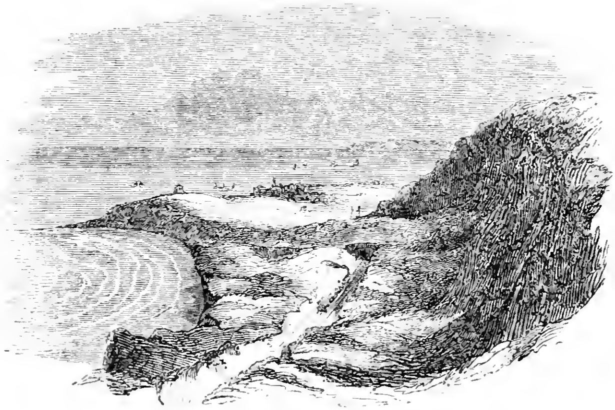
The long line of undercliff, the Warren, stretches in romantic beauty its chains of hill and dale along beneath the tall white cliffs, that proudly lift their lordly crests five hundred feet above the singing waves below.

Who is there amongst us with heart so dead as not to admire and delight in such a scene as this? Who, from the fairest of England's daughters to the sunburnt labourer, is dead to those charms of sense and scene which ever-varied Nature ever variedly presents to refresh the heart of the poor mechanic as thoroughly and as truly, as they do the gentler and more exquisite sensibilities of those who have never known a care.

"Come with me," says Lewes, in one of his beautiful 'Studies,' "come with me and lovingly study Nature, as she breathes, palpitates, and works under myriad forms of Life." Come with me,

too, and lovingly study Nature; only come with me with a stouter heart and bolder step, and let us venture one essay into the mysterious past.

Where shall we begin? "Anywhere," says Lewes, "will do." And truly so it will, for the geologist as well as for the naturalist.



Lign. 2.—The Warren, with Eastwear Bay and Copt Point, from the summit of Abbot's Clift.

We are already in the Warren. I remember it before it was spoilt by that great ugly gash of a railway-cutting, through which the fiery locomotive whizzes like a smoking rocket furiously along. I remember it in its solemn quietness; and oft, as the summer's glorious sun was placidly sinking in the west, have I wandered o'er its grassy mounds, or along its bordering sands beneath, where

"The prawn-catcher wades through the shore-rippling waves."

Beautiful indeed is that white land-locked bay in its fairy like purity. Serenity itself is that solemn glassed expanse of level water. How sweetly, too, the dying glories of the ruddy sun tip the highest peaks of chalky cliffs, while all below is shrouded up in solemn shadow, save off at sea, where

"Bright gleam the white sails in the stout rays of even,
And stud as with silver the broad level main;
While glowing clouds float on the fair face of heaven,
And the mirror-like water reflects them again."

Ever since I knew it has the Warren been just like this—almost unruffled in its solemn and stately aspect even by the stormy sea. Land, water, sky, all too broadly grand to be speckled by the pigmy waves, whose sullen sounds the mighty cliffs but backward throw, "faultering into whispers low." Here then let us begin.

There are older men than I that know the Warren well, and little is the change in it that they have seen. Like me they have grown from childhood into man; and more than I, they have passed into childhood—dreary, sad, exhausting childhood, not fresh and young—again; and yet little is the change that they have seen. There were those tall white cliffs when they were boys; there was that "wreck of ages" spread below; there was that broad mass of cliffs, and that wide solemn glass of sea that daily showed their pure white forms; there was that blue and slippery shore, those yellow sands, that rocky tract. Mounds of fallen chalk were piled against the cliffs beyond, while only a casual block tarnished the verdant carpet of the Warren.

Long years have flitted by since man recorded any change in this serene and solemn scenery. Already the recording lines on the tombstone's "frail and crumbling frame"—the dead man's chronicle —touched by time are half effaced. And then how slight the change recorded. Well may we look up at those old cliffs and think how old they are.

But need I say that once, in time's long sequence of changes strange, those cliffs were Ocean's mud—deep sea-bed ooze. How long ago is that? Older than the days when perhaps the brazen arms of conquering Romans clattered on this slippery strand; older than the days of Phoenician traffic with our island's mines for tin; older than the aboriginal Briton, or the hairy mammoths that inhabited this very land, ere Adam was, or human race began; older than that great and three-fold age (the Tertiary) when living species first appeared; older than ten thousand times ten thousand ages is the rock-mass of those fair and stately cliffs; and older still, older still by ages, is that dark blue clay that forms that slippery shore. And this blue clay it is that has made Folkestone one of the chief towns in the geological territory. Few geological localities have been longer or more justly celebrated in the annals of geology than

Folkestone has been for the beautiful iridescent fossils of the Gault; for by that provincial (Cambridgeshire) name is this blue stratum known to geologists. Not that these fossils are large or massive; not that they are parts and portions of the former monsters of the earth or sea; not that they have any economic value, or are capable of any commercial use. Probably they were not even the finest of their race while sporting yet with vital energy in their ancient sea; for only little shell-fish, or cuttle-fish were they—small, delicate, and pearly.

(To be continued.)

SOME GENERAL VIEWS ON ARCHÆOLOGY.*

By A. MORLOT, OF LAUSANNE, SWITZERLAND.

A century has scarcely elapsed since the time when it would have been thought impossible to reconstruct the history of our globe prior to the appearance of mankind; but though contemporary historians were wanting during this immense pre-human era, this era has not failed to leave us a well-arranged series of most significant vestiges. The animal and vegetable tribes which have successively appeared and disappeared have left their fossil remains in the successively deposited strata. Thus has been composed, gradually and slowly, a history of creation written as it were by the Creator himself. It is a great book, the leaves of which are the stratified rocks following each other in the strictest chronological order, the chapters being the mountain-chains. This great book has long been closed to man; but science, constantly extending its realm and improving its method of induction, has taught the geologist to study those marvellous archives of creation, and we behold him now unfolding the past ages of our world with a variety of details and a certainty of conclusions well calculated to inspire us with grateful admiration.

* This article is the introduction to a paper entitled "Geologico-Archæological Studies in Denmark and Switzerland," appearing in the "Bulletin de la Société Vaudoise des Sciences Naturelles" for 1859, and of which a separate edition, comprising the present pages, will be published.

The development of Archæology has been very similar to that of Geology. Not long ago we should have smiled at the idea of reconstructing the bygone days of our race previous to the beginning of history properly so called. The void was partly filled up by representing that ante-historical antiquity as having been only of short duration, and partly by exaggerating the value and the age of those vague and confused notions which constitute tradition.

It seems to be with mankind at large as with single individuals. The recollections of our earliest childhood have entirely faded away up to some particular event which had struck us more forcibly, and which alone has left a lasting image amidst the surrounding darkness. Thus, excepting the idea of a deluge which exists among so many nations, and therefore appears to have originated before the emigration of those same nations, the infancy of mankind, at least in Europe, has passed without leaving any reminiscences; and history fails here entirely, for what is history but the memory of mankind.

But before the beginning of history there were life and industry, of which various monuments still exist; while others lie buried in the soil, much as we find the organic remains of former creations entombed in the strata composing the crust of the globe. The antiquities enact here a similar part to that of the fossils; and if Cuvier calls the geologist an antiquarian of a new order, we can reverse that remarkable saying, and consider the antiquarian as a geologist, applying his method to reconstruct the first ages of mankind previous to all recollection, and to work out what may be termed prehistorical history. This is Archæology pure and proper. But Archæology cannot be considered as coming to a full stop with the first beginning of history, for the further we go back in our historical researches the more incomplete they become, leaving gaps which the study of material remains helps to fill up. Archæology, therefore, pursues its course in a parallel line with that of history, and henceforth the two sciences mutually enlighten each other. But with the progress of history the part taken by Archæology goes on decreasing, until the invention of printing almost brings to a close the researches of the antiquarian.

To pursue geological investigations, we must first examine the present state of our planet, and observe its changes—that is, we must

begin by physical geology. This supplies us with a thread of induction to guide us safely in our rambles through the past ages of our earth, as Lyell has so admirably set forth; for the laws which govern organic creation and the inorganic world are as invariable as the results of their combinations and permutations are infinitely varied, science revealing to us everywhere the perfect stability of causes with the diversity of forms.

So, to understand the past ages of our species, we must first begin by examining its present state, following man wherever he has crossed the waters and set his foot upon dry land. The different nations which at present inhabit our earth must be studied with respect to their industry, their habits, and their general mode of life. We thus make ourselves acquainted with the different degrees of civilization, ranging from the highest summit of modern development to the most abject state, hardly surpassing that of the brute. By that means Ethnology supplies us with what may be called a contemporaneous scale of development, the stages of which are more or less fixed and invariable; whilst Archæology traces a scale of successive development, with one moveable stage passing gradually along the whole line.*

Ethnography is, consequently, to Archæology what physical geography is to geology, namely, a thread of induction in the labyrinth of the past, and a starting point in those comparative researches of which the end is the knowledge of mankind, and its development through successive generations.

In following out the principles above laid down, the Scandinavian *savants* have succeeded in unravelling the leading features in the progress of pre-historical European civilization, and in distinguishing three principal eras, which they have called the Stone-age, the Bronze-age, and the Iron-age.†

This great conquest in the realm of science is due chiefly to the labours of Mr. Thomsen, director of the Ethnological and Archæolo-

* Some naturalists see a correspondence of the same sort between embryology and comparative anatomy, for they consider the human embryo as passing during its development through the different stages of the scale of animal creation, or, at least, as passing through the different states of the embryos of the different stages of that scale.

† The history of Danish Archæology has been sketched by T. Hindenberg. See "Dansk Maanedskrift," I. 1859.

gical Museums at Copenhagen,* and to those of Mr. Nielssen, professor at the flourishing University of Lund, in Sweden.† These illustrious veterans of the school of northern antiquarians have ascertained that Europe, at present so civilized, was at first inhabited by tribes to whom the use of metal was totally unknown, and whose industry and domestic habits must have borne a considerable analogy to what we now see practised among certain savages. Bone, horn, and chiefly flint, were then used, instead of metal, for manufacturing cutting-instruments and arms. This was the Stone-age, which might also be called the first great phase of civilization.

The earliest settlers in Europe apparently brought with them the art of producing fire. By striking iron-pyrites (sulphuret of iron) against quartz, fire can be easily obtained. But this method can only have been occasionally used, and seems to have been confined to some native tribes in Terra del Fuego.‡ The usual mode has been evidently that of rubbing two sticks together; but, on further reflection, it is easy to perceive that this was a most difficult discovery, and must at all events have been preceded by a knowledge of the use of fire as derived from the effects of lightning or from volcanic action.

The Stone-age was, therefore, probably preceded by a period perhaps of some length, during which man was unacquainted with the art of producing fire. This, according to Mr. Flourens, indicates that the cradle of mankind was situated in a warm climate.§

The art of producing fire has been perhaps the greatest achievement of human intelligence. The use of fire lies at the root of almost every species of industry; it enables the savage to fell trees,

* "Ledetraad til Nordisk Oldkyndighed." Copenhagen, 1836. Published in English by Lord Ellesmere under the title of "A Guide to Northern Antiquities," London, 1848.

† Nielsson. "Scandinaviska Nordens Urinvonare." Lund, 1838-1843.

‡ Weddell, "A Voyage towards the South Pole in 1822-1824." London, 1827. P. 167.

§ Flouren's "De la Longevité Humaine." Paris, 1855. P. 127. Man, from the construction of his teeth, his stomach, and his intestines, is primitively frugivorous, like the monkey. But the frugivorous diet is the most unfavourable, because it constrains its followers perpetually to abide in those countries which produce fruit at all seasons, consequently in warm climates. But, once the art of cooking introduced, and applied both to animal and vegetable productions, man could extend and vary the nature of his diet. Man has consequently two diets: the first is primitive, natural, and instinctive, and by it he is frugivorous; the second is artificial, being due entirely to his intelligence, and by this he is omnivorous.

as it allows civilized nations to work metals. The importance is so great, that deprived of it man would perhaps scarcely have risen above the condition of the brute. The ancients already were sensible of this. Witness the fable of "Prometheus." As to their sacred perpetual fire, its origin seems to lie in the difficulty of procuring it, thereby rendering its preservation essential.

In Europe the Stone-age came to an end by the introduction of bronze. This metal is an alloy of about nine parts of copper and one part of tin.* It melts and moulds well; the molten mass, in cooling, slowly acquires a tolerable degree of hardness—inferior to that of steel it is true, but superior to that of very pure iron. We therefore understand how bronze would long be used for manufacturing cutting-instruments, weapons, and numerous personal ornaments. The northern antiquarians have very properly called this second great phase in the development of European civilization the Bronze-age.

The bronze articles of this period, with a few trifling exceptions, have not been produced by hammering, but have been cast, often with a considerable degree of skill. Even the sword-blades were cast, and the hammer (of stone) was only used to impart a greater degree of hardness to the edge of the weapon.

The Bronze-age has, therefore, witnessed a mining industry which was completely wanting during the Stone-age. Now the art of mining is so essential to civilization, that without it the world would perhaps yet be exclusively inhabited by savages. It is, therefore, worth our while to inquire more closely into the origin of bronze.

Copper was not very difficult to obtain. In the first place, virgin copper is not exceedingly scarce. Then the different kinds of ore which contain copper, combined with other elements, are either highly coloured, or present a marked metallic appearance, and are consequently easily known; they are besides not hard to smelt, so as to separate the metal. Finally, copper-ore is not at all scarce, it is met with in the older geological series of most countries.

Virgin tin is unknown, but tin-ore is heavy, of dark colour, and

* Bronze is still used for casting bells, cannon, and certain parts of machinery. It must not be confounded with common brass, which is a compound of copper and zinc, much less hard, and appearing only in the Iron-age.

very easy to smelt. However frequent copper may be, tin is of rare occurrence. Thus the only mines in Europe which produce tin at the present day are those of Cornwall, in England, and of the Erzgebirge and Fichtelgebirge, in Germany.

But the question arises whether previous to the discovery of bronze, man, owing to the great rarity of tin, may not have begun by using copper in a pure state. If so, there would have been a copper-age between the stone- and bronze-ages.

In America this has really been the case. When they were discovered by the Spaniards, both the two centres of civilization, Mexico and Peru, had bronze composed of copper and tin, which was used for manufacturing arms and cutting-instruments, in the absence of iron and steel, which were unknown in the New World; but the admirable researches of Messrs. Squier and Davis on the antiquities of the Mississippi valley* have brought to light an ancient civilization of a remarkable nature, and distinguished by the use of raw virgin copper, worked in a cold state by hammering without the aid of fire. The reason of its being so worked lies in the nature of pure copper, which, when melted, flows sluggishly, and is not very fit for casting. A peculiar characteristic of the metal, that of occasionally containing crystals of virgin silver, betrays its origin, and shows that it was brought from the neighbourhood of Lake Superior. This region is still rich in metallic copper, of which single blocks attaining a weight of fifty tons have lately been discovered. There was even found at the bottom of an old mine a great mass of copper, which the ancients had evidently been unable to raise, and which they had abandoned, after having cut off the projecting parts with stone hatchets.†

The date of this American age is unknown: all we know is that it must reach as far back as ten centuries at least, that space of time being deemed necessary for the growth of the virgin forests, now flourishing upon the remains of that antique civilization of which the modern Indians have not even retained a tradition.

* Squier and Davis.—"Ancient Monuments of the Mississippi Valley." Smithsonian Contributions to Knowledge. Washington, 1848. It is one of the most splendid archæological works ever published.

† Lapham.—"The Antiquities of Wisconsin." Smithsonian Contributions to Knowledge, p. 76, 1855.

It is finally worthy of remark that the "mound-builders," as the Americans call the race of the copper-age, seem to have preceded and prepared the Mexican civilization, destroyed by the Spaniards; for in progressing southwards, a gradual transition is noticed from the ancient earth-works of the Mississippi valley to the more modern constructions of Mexico, as found by Cortez.

In Europe the remains of a copper-age are wanting. Here and there a solitary hatchet of pure copper is found; but this can easily be accounted for by the greater frequency of copper, while tin had usually to be brought from a greater distance, so that its supply was more precarious.

Europe did not witness the regular development of a copper-age. It seems, according to M. Troyon's very just remark, that the art of manufacturing bronze was brought from another quarter of the world, where it had been previously invented. It was most probable some region in Asia, producing both copper and tin, where these two metals were first brought into artificial combination, and where also traces of a still earlier copper-age are likely to be found.

An apparently serious objection might be started here, by raising the question how mines could be worked without the aid of steel. This, however, is sufficiently explained by the fact that the hardest rocks can be easily managed by the agency of fire. By lighting a large fire against a rock, the latter is rent and fissured, so as to facilitate considerably its quarrying. This method was frequently employed when wood was cheaper, and is even practised in the present day in the mines of the Rammelsberg, in Germany, where it facilitates the working of a rock of extreme hardness.

That metal of dingy and sorry appearance, but more precious than gold or the diamond—iron—at length appears, giving a wonderful impulse to the progressive march of mankind, and characterizing the third great phase in the development of European civilization, very properly called the Iron-age.

Our planet never produces iron in its metallic or virgin state, for the simple reason that it is too liable to oxydation. But among the aërolites there are some composed of pure iron, with a little nickel, which alters neither the appearance, nor the qualities of the metal. Thus the celebrated meteoric stone met with by Pallas in Siberia was

found by the neighbouring blacksmiths to be malleable in a cold state.* Meteoric iron has even been worked by tribes to whom the use of common iron was unknown. Thus Amerigo Vespucci speaks of savages near the mouth of the La Plata, who had manufactured arrow-heads with iron derived from an aërolite.† Such cases are certainly of rare occurrence, but they are not without their importance, for they explain how man may probably have first become acquainted with iron, and they also account for the occasional traces of iron in tombs of the Stone-age, if, indeed, this fact be well established.

It is, notwithstanding, evident that the regular working of terrestrial iron-ore must have been a necessary condition of the commencement and progress of the Iron-age.

Now iron-ore is generally found in most countries, but it has usually the look of common stone, being distinguished neither by its weight, nor colour. Moreover, its smelting requires a much greater degree of heat than copper or tin, and this renders its production considerably more difficult than that of bronze.

But even when iron had been obtained, what groping in the dark, and how much laboriously accumulated experience did it not require, to bring forth at will bar-iron or steel! Chance, if chance there be, may have played a part in it; but as chance only favours those privileged mortals who combine a keen spirit of observation with serious meditation and with practical sense, the discovery was not less difficult nor less meritorious. We need not, then, be surprised if man arrived but tardily at the manufacture of iron and steel, which is still daily being improved.

In Carinthia traces of a most primitive method of producing iron have been noticed. The process seems to have been as follows:—On the declivity of a hill was dug an excavation, in which was lighted a large fire. When this began to subside, fragments of very pure ore (hydroxyde) were thrown into it, and covered by a new heap of wood. When all the fuel had been consumed, small lumps of iron would then be found among the ashes.‡ All blowing appa-

* Pallas.—"Voyages en Russie," Paris, 1793, vol. iv., p. 595. There was but one mass of meteoric iron; it weighed 1,600 lbs.

† "Smithsonian Contributions to Knowledge," vol. ii., art. 8, p. 178.

‡ Communicated to the author by mining-engineers in Carinthia.

ratus was in this manner dispensed with—an important fact when we come to consider how much its use complicates the metallurgical operations, because it implies the application of mechanics. Thus, certain tribes in Southern Africa, although manufacturing iron and working it tolerably well, have not achieved the construction of our common kitchen-bellows, apparently so simple: they blow laboriously through a tube, or by means of a bladder affixed to it.

The Romans produced iron by the so-called Catalonian process, and the remains of Roman works of that description have been discovered and investigated in Upper Carniola, Austria.* The Catalonian forge is still used in the Pyrenees, where it yields tolerable results; but it consumes a large quantity of charcoal, requires much wind, and is only to be applied to pure ore containing but a very small proportion of earthy matter, producing scoriæ. The process, in fact, consists in a mere reduction, with a soldering and welding together of the reduced particles, without the metal properly melting. According to the manner in which the operation is conducted, bar-iron or steel are obtained at will. This direct method dispenses with the intermediate production of cast-iron, which was unknown to the ancients, and which is now the means of producing iron on a great scale.

Silver accompanied the introduction of iron into Europe—at least, in the northern parts; whilst gold was already known during the bronze-age. This is natural, for gold is generally found as a pure metal, while silver has usually to be extracted from different kinds of ore, by more or less complicated metallurgical operations—for example, cupellation.

With iron appeared also, for the first time in Europe, glass, coined money—that powerful agent of commerce,—and finally the alphabet, which, as the money of intelligence, vastly increases the activity and circulation of thought,† and is sufficient of itself to characterize a new and wonderful era of progress. From thence we can date the dawn of history and of science, in particular of astronomy.

* Jahrbuch der K. K. Geologischen Reichsanstalt. Vienna, 1850, vol. ii., p. 199. Carinthia and Upper Carniolia formed part of the Roman province Noricum, celebrated for its iron.

† "The circulation of ideas is for the mind what the circulation of specie is for commerce—a true source of wealth." C. V. de Bonstetten. "L'homme du midi et l'homme du Nord." Geneva, 1826, p. 175.

The fine arts also reveal, with the introduction of iron in Europe, a new and important element indicating a striking advance already in the stone-age, but more so in the bronze-age; the natural taste for art reveals itself in the ornaments bestowed upon pottery and metallic objects. These ornaments consist of dots, circles, and zig-zag, spiral, and S-shaped lines, the style bearing a geometrical character, but showing pure taste and real beauty of its kind, although devoid of all delineations of animated objects, either in the shape of plants or animals. It is only with the Iron-age that art, taking a higher range, rose to the representation of plants, animals, and even of the human frame. No wonder, then, if idols of the Bronze-age as well as of the Stone-age are wanting in Europe. It is to be presumed that the worship of fire, of the sun, and of the moon, was prevalent in remote antiquity—at least during the Bronze-age, perhaps also during the Stone-age.

The preceeding pages constitute a sketch, certainly very rough and imperfect, of the developments of civilization. They establish, however, in a very striking manner the fact of a progress, slow, but uninterrupted and immense, when the starting point is considered. The physical constitution of man has naturally benefitted by it. The details contained in the treatise of which the present paper forms the introduction prove that the human race has been gradually gaining in vigour and strength since the remotest antiquity.* The domestic races also—the dog first, then the horse, the ox, and the sheep have shared in this physical development. Even the vegetable soil has been gradually improving since the Stone-age—at least in Denmark. And yet there are persons who deny all general progress, seeing everywhere nothing but decay and ruin, like that worthy specimen of a Northern pessimist, who exclaimed—"See how man has degenerated; he has even lost his likeness to the monkey!"

* This agrees perfectly with the testimony of statistics. See "Quetelet sur l'homme et le developement de ses facultés." Paris, 1835, vol. ii., p. 271. This work of first-rate merit is very near akin to archæology. M. Quetelet has just published a new work, which will certainly be even more remarkable than the first, and which the author of the present paper regrets not to have had within his reach.

UPPER SILURIAN CORALS.

A SKETCH BY

GEORGE C. ROBERTS.

Coral-hunting in the *debris* of a Wenlock-shale quarry ranks high—to my thinking—amongst the pleasures of geology. And, indeed, has no insignificant place among its wonders. For to any one not conversant with zoophytic life, it is hard to believe that the rugged corals that lie strewn about the quarry, once held sensitive masses of life—that from every pore tiny arms waved to and fro in the water to entangle the lesser creatures they lived on; and that the animal—that slight thread of jelly-like substance, filling each tube, was at once a limb of the body and an independent creature, contributing, while attached, to the general support, and being able, if severed from the mass, to lead a separate existence and be itself the parent of others. The Wenlock series of the Upper Silurians have been rightly regarded as the metropolis of its zoophytic life, for both in variety and number, corals culminated in the seas of that age. Of these species, "so far removed from existing ones as to be quite unknown in modern seas, all, with rare exceptions, dying out at the close of the Palæozoic epoch."* I will essay a familiar sketch.

I adopt the nomenclature of M. Milne Edwards, whose valuable memoir of Silurian corals, published by the Palæontographical Society, is my guide and instructor.

True corals are called by zoologists Zoantharia; and those with which we have now specially to do belong to the order Anthozoa. They have again been divided into cup-, and star-corals—*Zoantharia rugosa*, and millepores—*Z. tabulata*. The first division may either be simple—tenanted by a single polyp, or compound—the result of an aggregation of polyps, the latter, as its name implies, must always be the shelter and defence for a community. The animal itself was a

* "Siluria," 3rd edition.

simple gelatinous substance, having power of expansion according to its wants, and being able to secrete lime from the ocean, and perhaps to transmute chemically other salts into lime, with which it built around itself a stony skeleton, a home to live in, and a defence from injury. In accordance with the thread-like growth of the polyp, we shall find these stony houses built up in most cases of tubes, through which the animal extended itself, the open end or summit forming its communication with the outer world.

These tubes are in most species crowned with a certain number of ridges, disposed like the rays of a star; these took their shape from the slender fishing arms of the polyp, and formed their protection. The summit of the tube is called the calice, or cup, and the ridges that radiate from its centre are known as septa. The beautiful pattern that covers the surface of a coral is owing to the preservation of these star-like septa, and by the variation in their forms and number combined with altered shape of the calice we distinguish species. For in this tiny cup are printed more definitely than elsewhere the characteristics of its inhabitant.

It is well to examine every piece of milleporal coral in three several ways. First, look at its upper surface and note the form and construction of its calices and the number, if any, of their septa; then, turning it sideways, observe whether the tubes of which these calices are the termination are continued to the base of the coral, or die away in its substance, and lastly, look at the under-surface, notice if the basal plate is free and unattached, or is furnished with a peduncle, or foot of attachment. But in describing the species, it is best to begin with the cup-corals. The normal form of this first great division of zoophytic life is that of a simple cup, produced by a polyp which expends all its strength in the development of a single calice. In some species, however, such solitary polyps are aggregated together, sometimes accidentally so, as in *Cyathophyllum articulatum*, usually found in groups of strongly-walled corallites, growing up together without interfering with each other; and in several species of cup-coral a peculiar method of reproduction—no less than "the life of the parent being continued in that of the offspring," by buds growing out of the centre of its calice, gives a composite character to what was before a solitary polyp. For the buds growing up and expand-

ing, crowd upon each other's limits, and a mass of corallites is the result, whose base is the old parent coral, and whose upper surface is covered by the star-rayed cups of the children. *Acervularia ananas* is the commonest species of these family corals.

The polyps that formed these cup-corals grew from their base upwards, and were probably long livers, for a well-matured specimen of *Cyathophyllum Loveni* will measure five inches in height, indicating by the number of prominent edges that surround it—accretion-wrinkles they are called—a long and chequered existence; for when these are regularly prominent, we infer the polyp led an active life of development. On the contrary, when their irregularity forms annular depressions on the corallum, these indicate the occasional repose of the zoophyte from its work of extension.

The common species belonging to these cup-corals are easily known. *Cyathophyllum Loveni* has very prominent accretion-wrinkles, while upon the sides of *C. angustum* they are but feebly developed. *C. pseudoceratites* has an oval calice, with only thirty-eight large septa alternating with a like number of smaller ones; the two former species have sixty of each kind. *Omphyma turbinata* is a short, wide-mouthed species, with double the number of septa, and has radiciform appendages, *i.e.*, rootlets, attached to its lower end. *O. subturbinata* differs only in being taller, as its name implies, having but eighty septa, and well developed accretion-wrinkles. *O. Murchisoni* is nearly allied, but has vesicles, or bladder-like tubercles, coming up among the septa. Then there is *Goniophyllum Fletcheri* with a square calice; *Aulacophyllum mitratum*, a small turbinated cup, whose principal and rudimentary septa combined only amount to sixty-eight, and *Ptychophyllum patellatum*, with one hundred septa, and the border of its calice so much raised that the corallum resembles the cap of a mushroom. These are all the simple cup-corals we are likely to meet with in the Wenlock rocks. Among the composite ones is the species I before alluded to, *Cyathophyllum articulatum*, generally met with as a mass of tall slender corallites, so thin-skinned that their upright internal lines of structure *(costæ)* are clearly visible. *Syringophyllum organum* is another, having star-headed tubes of exquisite beauty; and as a connecting link between this and the next division of cup-corals, we have *Acervularia luxu-*

rians, which resembles the preceding in the development of the inner walls of its corallites, but differs from them, and allies itself to the next by its mode of reproduction, which is exclusively calicinal. This gemmation, as it is called, is a very interesting and instructive feature. *Cyathophyllum truncatum* is a good example of it. I have often picked up this coral in a Dudley, or Wenlock lime-quarry, in which the parent—a simple, but somewhat angular shaped cup—has been smothered by the growth of young buds from out its calice. Indeed, in many specimens I have seen, these unnatural children have in turn borne young, and a tall turbinate mass of corallites, with calices mis-shapen by crowding together, has grown up.

The last division of the "cup- and star-corals" includes those composite species that have a common basal plate, and grow by accretional development. *Strombodes typus* is the best known. The star-headed terminations of its corallites cover the surface with irregular polygonal figures, the value of whose angles would puzzle old Euclid himself. This species has *vertical* internal radii, thus differing from its ally, *S. Murchisoni*, whose inner structure is completely vesicular. Another species, *S. Phillipsii*, has elegantly shaped calices, having their angles gracefully lengthened; while the perfection of beauty is attained by *S. diffluens*, whose surface, exhibiting no trace of walls dividing the corallites, is covered with the most exquisite septal floriations.

Nearly allied by form of calice to the cup-corals are the *Fungidæ*, or "mushroom-corals," an outstanding group of which one genus only seems to have lived in Silurian seas, *Palæocyclus* it is called, *i.e.*, ancient circle. *P. porpita* has a quoit-like corallum, thirty large septa alternating with a like number of smaller ones, and a curved peduncle-foot of attachment. *P, præacutus* is about the size, and not much thicker than a sixpence, has forty-eight uniform septa, and no peduncle. *P. Fletcheri* is about half an inch high, has a strongly curved peduncle, and well marked accretion-wrinkles; superior height gives it advantages, you see. But *P. rugosus* is taller still, somewhat top-shaped, and has a small peduncle, oddly turned up.

I have now to describe the milleporal corals, the second great

division of Silurian Zoantharia, differing widely from the cup- and star-corals, both in shape and character. They are all composite—no single tube or cup could be a millepore, either in fact or by courtesy, for the name implies the aggregation of a number of polyps having more direct connection with each other than the cup-corals. In shape they are both massive and branching. The first two genera, *Heliolites* and *Favosites*, are distinguished from each other by the absence of those septa in the latter that form such elegant star-like discs as they fill up the calices of the former.

Heliolites, *i.e.*, sun-coral, is so named from the sun-like appearance of its calices. *H. interstincta* has these calices closely set, and equal in distance from each other, the intervening space, called the *cœnenchyma*, being filled with polygonal cells. Upon the surface of *H. Murchisoni* the calices are not closely set, and vary in approximation. *H. megastoma* is easily known from either; large, closely set, calices cover its surface, and what cœnenchyma their nearness permits is made up of square cells. All these are massive corals irregularly hemispherical in form, and having a basal-plate strongly marked with concentric ridges. The branching Heliolites are still more elegant. *H. Grayii* is rudely branched, and bears its sun-like calices on both surfaces. The only known specimen of this species was found in the Wenlock shale of Walsall, and is in the cabinet of its discoverer, Mr. Gray, of Hagley. *H. inordinata* is decidedly arborescent in form, very slenderly branched, and bearing calices, whose rarity is made out by the extreme beauty of their form. This, however, is peculiar to Lower Silurian rocks, and I only introduce it here to complete my sketch of Heliolitic corals.

The genera *Plasmopora* and *Propora* differ from Heliolites, mainly in the appearance of their surfaces, the septal rays being prolonged beyond the edge of the calice, and united to other rays which cover the cœnenchyma. In every species of these three genera the number of septa contained in each calice is twelve.

Next come the *Favosites*. These have no intervening cœnenchyma, the coral being simply a bundle of tubes. The radiating septa of their calices are only developed in one species, and that a rare one, *F. Hisingeri*. *F. Gothlandica* is the typical form; this has strongly walled tubes, which, coming up to the surface, cover it with a cali-

cinal pattern of five-sided divisions, unequal in size. This differs mainly from *F. aspera*, in having its surface convex instead of flat. A broken piece of *F. aspera*, however, will show the edges of the tubes toothed, instead of smoothly columnar as in *F. Gothlandica*. *F. multipora* has its calices equal in size, and very regular. These three species are the giants of their tribe, specimens weighing sixty or eighty pounds are not uncommon in the Wenlock shale of Dudley, or Benthall Edge. A little below the Wych-pass at Great Malvern, where the Wenlock-shale rests against the west flank of the hill, a reef of Favosites crosses the footway, and may be traced in an unbroken line for some yards.

The calices of *F. Forbesii* are very unequal in size, and quite circular; this, though a massive species, never attains the size of its allies. A side view of *F. fibrosa* gives one the idea of a bundle of slender needles; consequently its calices are scarcely discernible without a lens. *F. cristata* is the only true branching Favosite; it may be known from other arborescent corals by the irregularity of form presented by its calices.

Alveolites is the genus most allied to the one I have been describing. It differs in this important and easily recognized particular; the calices of *Favosites* come up to the surface free and independent of each other, whereas in *Alveolites* each appears to overlap and intrude upon its neighbour, though not so in reality. The largest massive species, *A. Labecheii* is perhaps the most elegant in its calicinal pattern. *A. Grayii* is much like it, but has a flat instead of convex top, and the irregularity of the calices detract much from its beauty. *A. repens* is a very commonly met with branched species. *A.* (?) *seriatoporoides* is branched also, but seems intermediate between this genus and the next, *Cœnites*, for the calices are very sparely set among a greatly developed cœnenchyma, are quite circular, and arranged in perpendicular order. These *Cœnites* are beautiful branching corals, to be seen in every slab of Wenlock limestone; and though of small size, are not the least important of fossil zoophytes. The branches of *C. juniperinus* are round, or nearly so, and bear calices shaped like the Zodiacal sign Aquarius, or, to use a still more familiar simile, like birds upon the wing. The calices of *C. intertextus* have shorter and less elegant wings; while *C. linearis* is massive instead of branching, and has

simple line-shaped calices. These are all of small size. So, too, are the species of the next genus *Monticulipora*, *i.e.* "little mountain pore," from its surface being varied by the elevation of tuberosities. All the species of this genus are branching, save one—*M. papillata*, whose corallum is thin and incrustating. *M. Fletcheri* has circular calices regular in size; while those of *M. pulchella* are oval, or rarely hexagonal, but differ in size, those occupying the tuberosities being larger than those that come up in the low-lands. Three other species are met with, but rarely.

Next in order is *Labecheia conferta*, a disc-like coral, which is widely distinct from every other polyparian production; for the calices that come up abundantly to its surface are tubercles instead of cups, from their margins folding in upon the centre, and, as a matter of course, their septa are as rudimentary as are those of the *Favositidæ*.

Halysites catenularia is another aristocratic coral that does not permit others to claim affinity. This is the common "chain-coral," named so by universal consent, from its calices forming a series of interlinked loops across the upper surface, like the links of a golden chain. This is a pet species of palæontologists, for M. Milne Edwards has recorded no less than twenty-six synonyms for it *en vogue* at different times and places. It is abundant in every quarry of Wenlock shale, but the finest specimens come from Benthall Edge.

Now for the parasitical corals, *Syringopora bifurcata*, *S. fascicularis*, and *S. serpens*—three species not easy to distinguish at certain stages of their growth. They lived upon well-to-do shells and corals in those ancient seas, just as species with like habits do now, throwing up here and there a short calicinal tube as they crept over their surfaces. In after life gemmation out of these produced a mass of straight slender corallites, which had an independent existence, and grew tall and comely.

Two others, and the history of our common Wenlock corals is ended. *Thecia Swindernana* is a massive, but rather thin coral, having a flat upper surface covered with beautiful star-like calices, whose elegance of design is owing to the development of their septa. The other species, *T. Grayana* is like it in form, but differs in having but twelve septa instead of sixteen or eighteen.

With one or two exceptions, the whole of the corals I have here attempted to describe may be found within the limits of an hour spent in any quarry of Wenlock shale, or limestone. The few I have omitted to mention have but slight points of difference, and are accounted rare; but from a glance at this, every reader or collector will acknowledge that the coral-polyp held no mean place among the workmen of old.

CURRENT NOTES ON MINERALOGY, LITHOLOGY, AND METALLIFEROUS DEPOSITS.

By H. C. Salmon, F.G.S.

The October number of the "Philosophical Magazine" contains a notice, translated from Poggendorff's "Annalen," by Professor Gustav Rose, on the isomorphism of stannic, silicic, and zirconic acids. Stannic acid ($\ddot{Sn}$) forms the mineral *Cassiterite*, silicic acid ($\ddot{Si}$) is *Quartz*, zirconic acid, which Rose considers to be $\ddot{Zr}$, has hitherto been classed as an earth or oxide, as zirconia, with composition $\dot{Zr}$, or $\ddot{Zr}$. The mineral *zircon*, hitherto held to be a silicate of zirconia, must now, according to this, be merely considered as an isomorphous compound of one atom of zirconic acid and one atom of silicic acid ($\ddot{Zr} + \ddot{Si}$). This mineral species has always been remarkable for the variation of hardness and gravity in specimens from different localities, which according to this hypothesis may be accounted for by the unequal proportions of the two acids; the heavier and harder specimens containing the more zirconic acid, whose equivalent would be 481·20 compared with 384·888 that of silica. In the case of a variety found in Russia by Hermann, composed of two atoms of $\ddot{Zr}$, with three atoms of $\ddot{Si}$ ($\ddot{Zr}^2\ \ddot{Si}^3$), the specific gravity was only 4·06, while that of the mineral of the ordinary composition varies from 4·5 to 4·8.

Zirconic acid being thus established, and it being shown that zircon may be regarded as isomorphous with cassiterite (the ordinary

tin-stone or tin-ore), the former mineral is made, in the Profesor's reasoning, a kind of middle term to prove the isomorphism of its individual components (silicic acid and zirconic acid), with stannic acid. He considers, in fact, that silicic acid may fairly be considered to be already found in the form of cassiterite, in zircon; and believes it would not be a matter for surprise to find stannic acid in the form of quartz.

Dr. Genth's paper, in the September number of the "American Journal of Science and Arts," on the "Occurrence of Gold" is very suggestive. After the mass of vague verbiage with which we have been inflicted on this topic, it is really refreshing to find a man who, whether right or wrong, is at least possessed of a definite and comprehensible idea.

Dr. Genth maintains that the gold found in veins and alluvial deposits has been carried there in a state of solution; and he brings tho following instances to prove that, in those cases at least, such must have been the case. If these are accurately stated, of which there seems every internal evidence, this certainly cannot be questioned:—

"*a*, Specimen from Whitehall, Spotsylvania co., Va., shows gold associated with tetradymite [telluride of bismuth], limonite [hydrous per-oxide of iron], and quartz. The gold is crystallized in forms belonging to the rhombohedral system, and showing very distinctly one rhombohedron, scalenohedron and basal plan;* it is coating tetradymite, and is evidently a pseudomorph of it.

"*b*, The tetradymite of the Tellurium Mine, Fluvanna co., Va., and the native bismuth from the peak of the Sorato, in Bolivia, are frequently interlaminated with gold.

"*c*, In the upper portion of the ore-bed in the metamorphic slates at Springfield, Carrol co., Md., which near the surface consists of magnetite [magnetic proto-per-oxide of iron], and at a greater depth of chalcopyrite [copper pyrites] and other ores, films of native gold have sometimes been observed coating the cleavage-planes of tho magnetite. On close examination it can be perceived that below the film of gold the magnetite is oxidized into hydrated sesquioxide of iron."

In attempting to establish an hypothesis of this kind, the greatest

* These are the crystalline forms of tetradymite.

difficulty, as Dr. Genth truly says, "presents itself on inquiring into the nature of the solvent." The doctor believes the noble metal was dissolved as terchloride of gold :—"If we remember that the decomposition of pyrites produces sulphuric acid, which, in the presence of the never wanting chloride of sodium and a higher oxide of manganese, may liberate small quantities of chlorine, the most powerful solvent of gold, we have at least a very plausible explanation."

Dr. Genth's doctrine is that the gold both of veins and alluvial deposits is derived from the adjoining rocks, where it exists probably in a highly disseminated state ; from these rocks it is removed in a state of solution, and precipitated in concentrated deposits in the veins and among the alluvial *débris.* The rock in which the metal most frequently occurs is diorite or greenstone [composed of orthoclase felspar and hornblende]. How it originally came into this rock is not a question entered upon ; the main point being to prove that the gold of alluvial deposits is not derived, as is usually supposed, from the destruction of pre-existing quartz-veins, the fact being that they are both equally derivative, the original source being the neighbouring rock.

There are many considerations suggested by the mode of occurrence of gold which weigh strongly in favour of such a suggestion. In the first place, gold is continually found in alluvial deposits, in considerable sized nuggets, in districts where no veins are found. In this case the usual theory is that the original upper surfaces, which were rich in auriferous veins, have been removed by denudation, and that the alluvial gold is the remnant of these. But this has the disadvantage of assuming an hypothesis, for which no good reason can be given, that there is some peculiar law which limits the original production of gold to the surface, and which is held, with a strange inconsistency, by the same men who fully recognize the more than probability of other metals being derived from beneath. Assuming that the gold is derived from the rock by solution, and that the veins are mere depositories, we have at once at least a plausible reason for the general occurrence of gold only near the surface. It is that the solvent of that metal is somehow or other essentially connected with the atmosphere ; so that although gold may exist at all depths, scattered, highly disseminated through certain igneous rocks, it is

only where these rocks are subjected to a certain atmospheric decomposing action, by which the gold is dissolved, to be subsequently reprecipitated in a highly concentrated state, that it is found in appreciable quantities. This is strongly supported by the fact that the finding of the gold-deposits is not limited to any arbitrary depth, but generally extends as far as the effects of atmospheric decomposition, and no further.

The question of the origin of gold deposits by the deposition of the metal from solution is of course connected with the larger question of the origin of most veins, either of the metallic or non-metallic minerals, in a similar manner. Omitting Bischoff, who may be considered by some a prejudiced authority, there are many first-rate German mineralogists who hold the doctrine of such an origin for most mineral veins. This scientific infiltration doctrine must not, however, be confounded with a vague mining notion to the same effect, and which would refer such views to a connection with the present drainage of the country, and without any reference to an origin of the metals; an opinion which sometimes takes a form as loose as that expressed by the Roman poet:—

> "Inque brevi spatio, quæ sunt effossa reponit
> Tempus, inexhausti servans alimenta metalli."

No investigator on the subject of lithology has arrived at more sweeping conclusions as to the origin of rocks than M. Delesse in his "Etudes sur le Métamorphisme." Although M. Delesse's labours have been completed for more than a year, it is to be regretted that no complete abstract of them has been yet presented to English readers.* That memoir is too wide a subject to enter upon here; but a short reference to another paper, by the same author, in vol. xv. of the "Bulletin de la Société Géologique de France (p. 728), called "Recherches sur l'origine des Roches," in which he sums up the conclusions of the investigations detailed in his "Etudes" may be interesting to many.

* M. Delesse's memoir has been often referred to, and was particularly ably summed up by the President of the Geological Society in his last anniversary address, which should be consulted by all who wish to read a comprehensive review of the recent inquiries on this subject.

Referring to the agents which, in the interior of the earth, may have aided in rendering rocks plastic, or generally tended to the development of minerals, he reduces them to four—heat, water, pressure, and molecular action, attributing to the first only a comparatively limited *rôle* in the formation of eruptive rocks.

After describing what he conceives to be the action of these various agents, he thereon founds a classification of all eruptive rocks, according to their mode of origin, into the following divisions:

I. Igneous eruptive rocks.

II. Pseudo-igneous eruptive rocks.

III. Non-igneous eruptive rocks.

I. *Igneous* are those which have been reduced to a state of fusion, or at least rendered plastic by heat. They are almost always completely anhydrous, with a cellular structure and a rough feel to the touch, their constituent minerals having a strongly-marked characteristic vitreous aspect; they constitute the rocks regarded as eminently volcanic. As extreme types of this class he especially refers to, trachyte and dolerite.*

II. *Pseudo-igneous* rocks are those that may have been reduced to a state of plasticity partly by igneous and partly by aqueous action. Water, heat, and perhaps pressure may have combined to contribute to this. Rocks of this class have sometimes a cellular, or even scoriaceous structure; but their constituent minerals have only a slightly vitreous aspect. They are hydrated, often containing zeolites, and dividing into prisms or spheroids, and are generally associated with igneous rocks in volcanic regions. As types of this class he refers to retinite (pitchstone or phonolite), basalt, and trap.† These two classes represent those rocks usually called volcanic.

* Trachyte is a rock containing orthose and anorthose felspar, ferro-magnesian mica, hornblende, and also quartz. By anorthose felspar is designated, in a general way, all the felspar species belonging to the sixth crystalline system. Dolerite is an anorthose and anhydrous lava, composed of anorthose felspar and augite, with sometimes olivine, mica, and leucite.

† Retinite consists of vitreous orthose felspar, of ferro-magnesian mica, and also quartz rather rarely, and always a large proportion of water, which may rise from 10 to 100 per cent. Pechstein and phonolite are varieties of this rock. Basalt principally consists of anorthose felspar, augite, and olivine, with sometimes protoxide of iron, carbonates, zeolites; and accidentally nepheline, haüyne, zircon, corundum, &c., forming a hydrated felspathic paste. Basalt has the

III. The *non-igneous* rocks correspond to Lyell's plutonic rocks. Their plasticity was due to the combined action of water and pressure, heat having only played a very secondary part in their formation. In them the constituent minerals are devoid of the vitreous aspect peculiar to the igneous rocks; and their structure is rarely cellular, but, on the contrary, generally very compact. They are not associated with volcanic rocks, and are consequently attributable to an entirely different mode of origin. As types of this class he selects granite, diorite, and serpentine.*

Conclusions such as these, so strongly opposed to many of our preconceived notions, are not likely to be received in this country with undue favour. M. Delesse on some points surpasses Bischoff,

same elementary composition as dolerite, differing principally in the presence of a certain quantity of water and volatile matters.

Trap, properly so-called, may pass into basalt, with which it is often associated. An intimate relation exists between the two rocks, but heat only played a very minor part in the formation of trap. Its base is anorthose felspar, which is generally the only mineral possible to be recognized; this is always hydrated, often considerably. It is rich in oxide of iron, and often contains spathic carbonates. Trap forms the limit of the pseudo-igneous rocks; and although it is intimately connected with basalt, it differs I think in having been formed in a lower-temperature.

* Granite, as a type of a large class of rocks, has almost the same mineral composition as trachyte, for it contains quartz, felspars, and micas; but the occurrence and characteristics of these minerals are very different. Its quartz is particularly worthy of remark. In rocks of igneous origin this mineral is often entirely wanting; now, in granite, on the contrary, it is very abundant, amounting to even a moiety in certain rocks, yet the total quantity of silicic acid present is not greater than in trachyte; the greater abundance of free quartz being due to the facilities which the mode of origin of granite afforded this mineral of separating itself from the magma. It must be borne in mind also that this quartz is not only always crystalline, but also always hyaline. The study of the felspars of granite is also very instructive. They are orthose and anorthose, opaque, or at most translucent, never vitreous, and always contain a certain quantity of water, usually trifling in the orthose, but varying from 2 to 100 per cent. in the anorthose. The consideration of the micas and other minerals of this rock are equally instructive in showing its aqueous origin.

Diorite has a very simple mineralogical composition, being essentially formed of anorthose and hornblende, with, at times, protoxide of iron, sphene, ferro-magnesian mica, and, accidentally, garnet. Diorite greatly approaches granite in its mineral composition. Its metamorphism is analogous, and the one may pass insensibly into the other. Diorite may be considered as formed under conditions intermediate between those that have produced trap and granite.

Serpentine has hitherto, of all the eruptive rocks, been the most enigmatical. Its mineralogical characters are so well known, that it is unnecessary to repeat them; but it is particularly distinguished by its large per centage of water, varying from 13 to 100 per cent. In this rock all effects of heat have entirely disappeared, and its plasticity can scarcely be attributable to any other causes than water and pressure.

and indeed most modern investigators, in the sweeping nature of the power he attributes to aqueous action. He may, in some degree, exaggerate this; but it is useless to close our eyes to the evidences of the great revolution in opinion, which has recently taken place on the Continent on the subject of the origin of rocks. The doctrine of the force of pure igneous causes, such as students will find in almost every English text-book, has now only a minority of supporters in Germany and France. Wide differences of opinion, however, yet exist, which may be expected to give rise to prolonged investigations and discussions.

The following epitome of some of M. Delesse's more general views will give a notion as to the mixed nature of the causes to which rocks owe their origin:—

"The problem of the origin of eruptive rocks is one of the most complex in geology, and has given rise to interminable discussions, in which the most opposite systems have seemed in turns to triumph. These revulsions in opinion, sometimes very sudden, are to be attributed to the exclusive importance attributed to one or the other agents which have aided in the formation of rocks. In popular language it is said that no two things can be more opposed than fire and water; but in nature no such antagonism exists, these two agents often acting together. This should be always borne in mind in any inquiries into the origin of rocks. When therefore we speak of an igneous or an aqueous rock, we do not mean to restrict these terms to their exact sense; we must necessarily attribute to them a meaning different from that of common language. When we say a rock is of igneous origin, we do not necessarily say that it has been reduced to a state of fusion by heat alone: similarly, speaking of an aqueous origin, we by no means limit the causes to the unique action of water. In speaking, therefore, of a cause, it must always be understood that it is only referred to as the principal agent of formation. Of the causes referred to—heat, water, pressure, and molecular action—one may have played a preponderant, but rarely an exclusive part. Molecular action, also, it should be borne in mind, must only be considered as a secondary cause, for it seems to have been induced either by heat, water, or pressure. Electricity itself, which accom-

panies and causes this molecular action, seems to result from these primary causes. As, therefore, on the whole, the chemical and mineralogical composition of rocks varies little, and as it is easy to see that one and the same mineral may have had, at times an aqueous origin, at times an igneous one, we have no reason to be surprised if it is not always possible to trace the rigid limit between rocks which, at first sight, seem the most opposite, such as those engendered by heat or by water."

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London, *January* 4, 1860.—Prof. J. Phillips, President, in the Chair.

The following communications were read:—

1. "On the Flora of the Silurian, Devonian, and Lower Carboniferous Formations." By Prof. H. R. Goeppert, For. Mem. G.S.

2. "On the Freshwater Deposits of Bessarabia, Moldavia, Wallachia, and Bulgaria." By Capt. T. Spratt, R.N., C.B., F.R.S., F.G.S.

3. "On the Rhizopodal Fauna of the Mediterranean compared with that of some of the Italian and other Tertiary deposits." By T. Rupert Jones, F.G.S., and W. K. Parker, Mem. Micr. Soc.

The authors presented an extensive table of the Species and varieties of recent *Foraminifera* from several localities in the Mediterranean (worked out from material gathered and dredged by Capt. Spratt, Mr. Hamilton, Prof. Meneghini and other friends), and of the fossil forms from the Tertiary deposits of Malaga (Spain), Turin, Sienna, Palermo, and Malta (communicated by Prof. Ansted, Prof. Meneghini, and the Marchese C. Strozzi, or supplied from the Society's Museum); also the fossil *Foraminifera* from Baljik supplied by Capt. Spratt, and those of the Vienna Basin as elaborated by D'Orbigny, Czjeck, and Reuss. The recent *Foraminifera*, tabulated in eleven columns, were illustrative of the range of the respective species and varieties in different zones of sea-depth, from the shore to one thousand seven hundred fathoms, and of the relative size of the individuals, and of their proportional paucity or abundance. Among the seventeen columns of fossil *Foraminifera*, some were very rich in species and varieties, especially in the case of the Siennese clays, the Malaga clay, and the Vienna basin. From the evidence afforded by the comparison of the fossil with the recent *Foraminifera*, the Siennese blue clays of S. Cerajolo, S. Donnino, S, Lazaro, and Coroncino were regarded as having been deposited in various depths of from forty to one hundred fathoms; so also the clay-beds of Malaga and of the Vienna basin. A blue clay from S. Quirico was probably formed in about two hundred fathoms; a blue clay from Pescajo, on the contrary, was the deposit of a shallow estuary. A sand from Pienza, and others from Montipoli, Castel'Arquato, and San Frediano, contain *Amphistegina*, and were probably deposited in from ten to twenty fathoms water. As the *Amphistegina* appears now to be extinct as regards the Mediterranean, these Amphistegina-beds, and others at Palermo and in the Vienna Basin, may be of miocene age. Another Siennese clay from Monti Arioso is of shallow water

formation. From Turin some shelly sands, of pliocene age, were defined as containing a group of *Foraminifera* similar to those now living on the western shores of Italy; and the Palermo deposits are, for the most part, not very dissimilar. The Heterostegina-bed at Malta, formed probably in rather shallow water, is characterized by a species now absent from the Mediterranean. The tertiary deposit from Baljik appears to have been a shallow water deposit, characterized by some forms peculiar at the present day to the Red Sea; a condition that is also indicated by some of the Viennese deposits.

Liverpool Geological Society.—The first meeting of this society was held on Tuesday, the 10th of January last.

Prof. Phillips, President of the Geological Society of London; Prof. Ramsay, Director of the Geological Survey of Great Britain; Prof. Jukes, Director of the Geological Survey of Ireland; Prof. Morris, F.G.S.; and S. J. Mackie, Esq., F.G.S., F.S.A., were elected honorary members.

The President, Henry Duckworth, Esq., F.R.G.S., F.G.S., then read the inauguration address. After congratulating the members on their assembling together for the first time as a constituted body, he proceeded to point out the objects of the society.

The geology of Liverpool and its immediate neighbourhood was next touched upon, and afterwards that of the surrounding country, especially of North Wales, the President calling particular attention to the comparative ease with which such deeply interesting localities as Church Stretton, Coalbrookdale, and Ludlow—the portals of the Silurian system—might be reached.

The President then gave a *resumé* of the progress of geological science during the past year.

A paper was then read by the Secretary, G. H. Morton, Esq., F.G.S., "On the Basement-bed of the Keuper Formation in Wirral,* and the South-west of Lancashire."

Interesting specimens of fossils and minerals were exhibited at the meeting by various members.

[The abstracts of Prof. H. R. Goeppert, Capt. T. Spratt, and Mr. Morton's paper will be printed in the next number.]

NOTES AND QUERIES.

On the Lower Silurian Rocks in the South-East of Ireland, and on a Human Skeleton in an elevated Sea-Margin.—Dear Sir,—In the year 1840, when persevering in what was considered at the time a hopeless task—that of searching for fossils in the contorted old schistose and slaty rocks so extensively developed in the counties of Waterford, Wexford, and Kilkenny—I at length discovered at Duncannon, in the county of Wexford, a patch of rocks which I considered might be referred to the Llandeilo formation. Although the correctness of this view has been questioned, and it has been broadly asserted that *all* the Silurian Rocks in the south-east of Ireland

* Wirral is the western extremity of Cheshire.

are confined to the Caradoc group, yet I believe that it will be eventually acknowledged that the fossils from Duncannon are Llandeilo types, such as *Calymene duplicata*, *Beyrichia complicata*, *Lingula attenuata*.

All the Silurian mollusca from Duncannon, except the black horny Lingula, have a white silky appearance, in striking contrast to the dark matrix in which they are imbedded. This, I imagine, is owing to the shells having been at a remote period slowly and partially calcined by the action of the heat from the igneous rock in the vicinity.

The mineral character of the rock also agrees with the Llandeilo flags and dark-coloured schists so well developed in Wales. I therefore wish to record my view of the age of similar dark-coloured rocks at Duncannon, more especially as I cannot without great difficulty refer them to the Caradoc series, a patch of which I discovered on the opposite shore of Waterford Haven. The trilobites which I obtained there were lent to be described in a work on a northern Irish county then publishing.

It is to be regretted that, in Portlock's Report of Londonderry and Tyrone, the trilobites which I obtained at Newtown Head are stated to have been discovered by me at Tramore. The mistake no doubt arose from there being two localities named Newtown Head, one near Tramore, and the other situated between Passage and Woodstown, on the western shore of Waterford Haven, which I fully explained at the time, but which was unfortunately lost sight of.

Although a paper of mine, giving a brief account of these fossiliferous strata had been read at a meeting of the Geological Society in 1841, the discovery of those Silurian rocks has been erroneously ascribed to the Ordnance Geological Survey in Ireland (Mem. Geol. Surv., Decade 2, pl. x., p. 4); and one of the very trilobites which I had lent, has been dedicated by Mr. Salter (at page 3, pl. 7, decade No. 2), to the author of the work above alluded to, as its discoverer. So far from the Government Surveyors having discovered the fossiliferous rocks in question, they were wholly unknown to the Survey until I pointed them out to Colonel James, R.E., in the spring of 1841. Well might the Surveyors pass them by, for they can only be approached with an ebb tide; and as they are quite level with the shore, the adjacent cliff being destitute of fossils, they did not attract notice till the publication of my paper.

Eventually these rocks will be covered by the accumulation of the silt and sand which are deposited at every tide, so that all trace of them will be lost.

Continuing my search for organic remains on the Waterford side of the estuary, I was rewarded, as above indicated, with the discovery of lower Caradoc rocks of limited extent, which, as I have related, are situated on the shore at some little distance from the cliff at Newtown Head, near Woodstown. From collecting fossils, I proceeded, in company with my son, Mr. T. Austin, to examine the clay which caps the mass of trap and other rocks forming the headland. The clay which covers the rocks along the line of section, with the exception of the quarry, where it has been removed for the purpose of procuring stone for road-mending, is continuous from Woodstown Strand to Raheen Bridge, which latter is a small structure over the shallow brook that runs down from the high ground to the south of Crook Church and Castle—both edifices in ruins. The rivulet, more to the south, is a mere rill, that has cut its way rather deeply down through the clay. This clay is similar in composition to the drift which covers a great part of the south-eastern district of Ireland. When engaged in examining the clay and tracing the line of a bed of cockles, which, with occasional breaks in its continuity, extends along the coast, and for a considerable distance inland, from Raheen Bridge to Woodstown Strand, a distance of upwards of eight hundred yards, a bone was

unexpectedly discovered in the cliff. On removing some of the surrounding clay, the bone was found to form part of a perfect human skeleton, which was lying in a position parallel to the cockle-bed, which bed was continuous and unbroken on both sides of the human remains. A portion of the skeleton was rather below the line of shells, while the clay and cockles had entered the skull, and followed the same line as the shelly bed on either side of it. It was also quite evident that the incumbent earth had never been disturbed from above since its upheaval; and the clay is so perfectly dry, that bones might remain undecayed in it for an indefinite period; and the shells are apparently all but as fresh as those of the same species that are daily cast on shore by the waves. A brief notice of this discovery was read at a meeting of the Geological Society in 1841, when the skull, with the shells in it, was exhibited. The cliff is elevated about forty feet. The circumstance attracted at the time less attention than a fact of the kind deserved, but subsequent discoveries of flint implements in the drift has converted what was at first considered of little account into an important fact; and I have been urged by my geological friends to call attention to the subject in your widely circulated periodical.

Explanation of the Section.

a, Clay; the line near the top representing the bed of cockles.

b, Trap-rock.

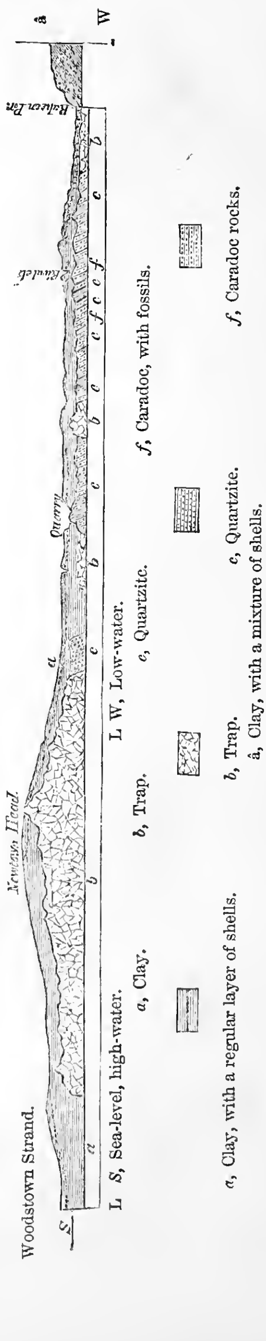
c, Quartzite, probably caradoc sandstone altered by contact with the igneous rock against which it abuts.

f, Caradoc-rocks, rich in fossils.

At *a* x is noted the spot where the human skeleton was imbedded.

Height of section forty feet; horizontal extent about eight hundred yards. In the rough draft the vertical height has been exaggerated, in order to exhibit the stratified rocks more distinctly.

At the time the human skeleton was disovered, it was asked if any tradition existed in the country of a change of level on the coast, but I have no doubt that the entombment of the human remains and the cockles occurred



Section, North and South, on the Western Shore of Waterford Haven, South of Passage, County of Waterford.

long anterior to even traditionary lore; and that too many generations of men have passed away to preserve and hand down to the present day an account of remote physical changes, which being local in their nature, and in no way interfering with the requirements of man in a rude and barbarous state, living probably by the produce of the chase alone, would make no lasting impression on his uncultivated mind; or it is quite possible that the adjacent district was uninhabited, and that the body may have been transported from the interior to the spot in which it was found, as three noble rivers—the Suir, the Nore, and the Barrow—unite their streams, and flow into the estuary above the village of Passage, to the north of Newtown Head, where a wide expanse of salt-water mingles with the confluent streams as they pass onward to the sea.

The changes indicated by the rather wide-spread bed of cockles point to a period of time when the waters of the estuary occupied a much wider space than at present; when the sediment was accumulating to a greater depth before the cockles existed and were destroyed, and the entombment of the human body, than it did subsequently.

In connection with the remains of man occurring in an ancient raised sea-bed, is the fact that so many flint implements have been found in the drift, which seemingly carries us back to a period when Europe and the British isles were inhabited by a race of savages, among whom the use of iron or other metals was unknown; and who, strangers to the arts of civilized man, had contrived to make those rude flint implements, which are now found in the drift, to supply the wants of men in a state of nature, testifying to their remote antiquity.

With respect to the great antiquity of the human race, and considering our method of computing time, the questions naturally arise—Are we wholly wrong in our chronology? and, Are the Chinese and Egyptians in their reckoning nearer the truth than the western nations? Every opposition will be made to the proper solution of these questions by those who are averse to the progress of science, and every effort to explain away the facts bearing on this most important and interesting inquiry will be essayed by its opponents.

Some persons wholly deny that the chipped flints, or "celts," which are found in the drift are the work of human hands, and attribute their peculiar forms to the action of running water; others consider that they are the production of some subterranean manufactory, which volcanic explosions have sent forth rough cast, so that on cooling they became fractured, and assumed their present forms. Others, again, believe that frost had much to do with shaping the "langues des chats." Thus, heat, cold, fire, and water are made to produce one simple effect—in short, anything, except the more rational supposition that they are the vestiges of man's works; a fact that is admitted by those whose opinions are entitled to much weight in such matters. Whatever age may be finally assigned to the drift and the ancient sea-margins, one thing appears clearly established, namely, that an aboriginal race of men inhabited the earth prior to the superficial accumulations on parts of its surface, and long ere the noble savage had discovered the use of iron or other metals, or the secret of their manufacture.

I found no novel theory on the discovery of the human skeleton in the ancient estuary clay, or the flint implements in the drift; but I offer these observations, believing that the two facts taken in connection with each other will stimulate inquiry, and probably lead to a satisfactory solution of a question highly interesting to man, and which inquiry may tend to establish the truth—which is the chief end and aim of science.—T. Austin, Kingsdown, Bristol.

Query respecting the Geological Characters of the Gravels of St. Acheul, &c.—Sir,—I do not consider myself to be a geologist, though for

many years I have read much on the subject, and listened to all I could hear upon it; yet for want of practical out-of-doors observation, I can but look on myself as an amateur or admirer of the science, and not a professed geologist. I dare say, therefore, in what I am about to write, I may commit some geological heresies; nevertheless, I venture a few remarks upon a subject that has lately been much agitated in the geological world—I allude to the discovery of works of human art, viz., flint-axes, &c., in the drift near Amiens, &c.

This discovery seems to be thought by some to upset the doctrine hitherto held of the recent origin of the human race on our globe, and I have even heard it said that it upsets the Bible history of that event.

To me it appears that no such result can follow the proof (if the fact be proved) of man's existence cotemporaneously with the deposition of the drift. That might, indeed, carry the geological date of man's existence further back than hitherto supposed, but not the chronological date of his creation—that is if it be a fact established beyond doubt that drift is clearly a formation which has been deposited prior to the modern deposits, as they are called, in which last alone remains of man and his works have heretofore been supposed to have been found.

The supposed discovery of flint hatchets in the original drift would not vary the chronological date of man's creation, but only prove that the drift, hitherto supposed (from the absence of man's bones and works of art) to be a pre-adamite formation, is, in fact, post-adamite, and one of the modern formations. At least that is the conclusion I should come to, and not that the period of man's existence on earth is shown thereby to be at all more ancient than hitherto supposed, but only that the time of the deposition of the drift is not so far back in point of time as it had been calculated to be.

I see no reason, therefore, for that fear which some have expressed lest the investigation of the alleged discovery should unsettle men's minds as to the truth of the Bible history of man's creation.

Now, sir, I have carefully read what Sir Charles Lyell said on this subject in his address at the meeting of the British Association at Aberdeen, and all that was said there, and since upon it by others, and I had almost come to the conclusion that man was cotemporaneous with the mammoth and other extinct animals whose remains are found in the drift, when I happened to read in the "Times" of the 18th November, 1859, a letter from Mr. J. W. Flower, who, on the whole, seems to me, from an examination of the circumstances of the case on the spot, near Amiens, to have arrived at the conclusion that man was in existence when the drift was deposited there as a geological formation, although he is still somewhat perplexed with certain difficulties that present themselves to his mind.

The perusal of Mr. Flower's letter has, however, led my mind to a totally different conclusion, and from the description contained in it of what he saw and did, and of the circumstances of the case, I arrive at the result that the particular place in the drift, where alone it seems these flint hatchets have been disinterred, is an ancient Celtic tumulus.

It seems, from what I gather, that this drift near Amiens is not one continuous bed of gravel, but occurs in localities distant from each other; that the part of the spot in the drift where the flint hatchets alone are found is at Saint Acheul, and does not cover a space larger than a modern dwelling-house; the nearest point where the drift occurs again being at Saint Roch, I think two miles distant; moreover, it is near Amiens, which in Julius Cæsar's time was a well-known Celtic town called Samara Briva. And Julius Cæsar himself tells us the Celts were accustomed, in burying their dead, to bury their valuables with them. It seems that the *locus in quo* is of an average height of twenty feet, and forms the capping or summit of a slight elevation resting on

the chalk—exactly such a situation as both Celts and Scandinavians chose for the tumuli of their great warriors. Many of their tumuli are entirely formed of stones heaped together, though most of them have earth mixed with the stones. In Yorkshire we have tumuli larger than this at Saint Acheul would seem to be—for instance, one near Braffords and Wauldby Wood, which is probably that in which Ivar Beenlose, the son of Regner Lodbrog, caused himself to be buried on the coast near the Humber, and which Worsoe, in his "Danes and Norwegians in England," mentions (at page 38) that William the Conqueror caused to be opened. Another tumulus of greater size occurs between Newbald and Beverley, and others near Porkthorpe, between Driffield and Hunmanby. The size, therefore, is no objection to the patch at Saint Acheul being a tumulus in which these flint hatchets are found; and, observe, they are not found in the drift at Saint Roch, nor in any of the other patches, but they ought to be found throughout the whole of the drift in that locality, if deposited along with the drift itself. Moreover, if the hatchets had been brought to Saint Acheul along with the original drift at the time of its deposition by nature, they would have been water-worn like the drift gravel itself; whereas they appear to be formed from rolled flints, but the worked part not in the least water-worn, showing they were constructed since the water-wearing of the companion drift in which they exist.*

From a description by Mr. Flower, I entertain great doubts whether this patch of drift gravel on the summit of an elevation about one hundred feet high was deposited there at all by the drift forces; but if it were so, the ancient Celts may still have availed themselves of it as the covering, or tumulus of the grave of one of their great chiefs. I much incline, however, to the opinion that the natural rise of one hundred feet (the only one it seems thereabouts) has been selected as the site of the tumulus, and the gravel brought at, or after the funeral, from Saint Roch, and heaped over the body, for it is clear that the raised materials of many tumuli in England have been brought from some distance, and the labour of a whole tribe bestowed for a few weeks would suffice to do that honour to the memory of their deceased chief at Saint Acheul. The higher a chief was in the esteem of his people the larger his tumulus, and the greater the pains bestowed on it. Some of these tumuli called by the Celts cromlechs, had a stone chamber within them for the corpse, and in them, too, the mound was not unfrequently composed of stones instead of earth—see Sir Richard Colt Hoare's work on the subject, and Wright's "Celt, Roman, and Saxon," at page 63 of which you will find it was always the desire of chiefs to be buried in lofty situations. Sometimes the body was deposited on the ground and the tumulus heaped over it; but in the Wolds of Yorkshire, the earth has often been removed down to the chalk, and there the body deposited; and I apprehend if there was an original deposit of drift gravel on the summit of the hill at Saint Acheul, it would be removed down to the deposit preceeding it, and the body there laid, and then the gravel again heaped on it. But as I said before, it is not improbable (as the patch of drift is only of the extent of a modern dwelling-house) that it has all been brought from Saint Roch.

Stone hatchets have been found in British tumuli. Why not then in French ones?

I do not find any account of the precise sort of locality in which the Abbeville hatchets are found; but if they also are confined to particular spots in the drift bed, and not found in all parts indiscriminately, it would go far in my mind to establish the idea of those being graves where the hatchets are found.

* Some specimens collected by M. Boucher de Perthes, now by loan of Mr. Flower in my possession, I think are slightly water-worn. Some of these "celts" may have been, manufactured from flints taken directly out of the chalk; others, I am inclined to believe, have been manufactured from large gravel flints.—Ed. Geologist.

At all events, might it not be worth the while of geologists, as well as antiquarians to have the Saint Acheul patch of drift cut through the middle to see if any more conclusive evidence of its being a place of burial cannot be discovered.

It is by no means uncommon to find tumuli constructed of one material—say earth—at the bottom, then stone over that, and again a third material—as gravel or sand—over all, thus artificially producing an appearance of stratification, such as I learn the elevation at Saint Acheul presents. The idea which I have seen maintained that the hatchets are a natural production I cannot imagine will find many adherents. No doubt they have been chipped into form by art, let the means of their present position be what it may.

In 1835 I read a paper here in which I showed how exactly Job's description of the Leviathan tallies with that of the Megalosaurus, and his description of the Behemoth with that of the Iguanodon, and I then broached an idea that although the Wealden era was the flourishing period of Megalosaurian and Iguanodonic existence, I saw no reason why individual animals of those species should not have been found existing still on the earth in Job's time, though rapidly becoming extinct (my paper was inserted in the "London Magazine," for April 1835). Now, having committed myself to such an opinion as that, you will see I cannot be prejudiced against any theory which would make man and mammoths contemporaries to some extent, and therefore have not adopted the tumulus idea from prejudice.—I am, sir, yours truly, Tho. Thompson, Wilton, near Hull, December, 1859.

Silurian Rocks at Abergele, &c.—Dear Sir,—I shall be much obliged if you or any of your readers will kindly furnish me, through the pages of the "Geologist," with an abstract of the late Mr. Bowman's paper on a small patch of Silurian rocks west of Abergele, published in the second volume of the "Proceedings of the Geological Society."

And perhaps Mr. Price, of Birkenhead, who appears to be acquainted with the locality, will inform me if he knows whether the dark fossiliferous shale, usually rich in Terebratulæ, Chonetes, and the smaller Producti, developed at various points along the North Wales belt of Carboniferous limestone towards the top of the series, is exhibited in any of the sections in the neighbourhood of Llysfaen, Llanddulas, and Abergele.

With many thanks for kind answers to former queries, dear sir, yours truly, David C. Davies, Oswestry.

Mr. Bowman's remarks are given in an abstract occupying a page and a-half in the Proceedings of the Geological Society (vol. ii., pages 666, 667), a copy of which we have despatched to our correspondent. We insert his communication for the purpose of facilitating his inquiries by replies from Mr. Price and other readers.

Slickensides in the Chalk.—Professor Ansted, in his answers to Mr. Price's query, No. 24, states that slickensides do not occur in the chalk. I must differ from that assertion, inasmuch as I know that slickensides are, at least of very common occurrence in the chalk of the Kentish coast between Deal and Folkestone, especially between Deal and Dover will the investigator find numerous slight faults or partings dislocating the strata to the extent of a foot or two, the surfaces of the opposing planes presenting all the usual characters of ordinary slickensides. I am also well acquainted with one of considerable extent, which might, during the construction of the South-Eastern Railway tunnel through the noted Shakespeare's cliff, have been turned to practical and profitable account. An extensive slickenside-plane extended diagonally across the mouth of the tunnel for the whole vertical height of the cliff, there varying from one hundred and fifty to three hundred feet in height. Had this been taken advantage of, and the surplus chalk cleared away carefully

to this natural facing, the whole expense of digging out the corner of the cliff, and the building of two rectangular walls of brick to support and protect the artificial face of the cliff thus excavated might have been avoided; for so smooth a surface resting so nearly at the true angle of repose as the plane of the slickenside there presented, would have been perfectly safe without any extraneous support whatever.

Any one travelling along the Brighton, Croydon, or North-Kent railways, or, indeed, any one visiting any large chalk-pit or cliff-section can, we think, hardly fail to notice slickensides of greater or less extent.

In the lower beds of the white chalk, and in the lower beds of the grey chalk, there are cones of chalk having glossy slickensided surfaces, the origin of which I have never been able to account for, unless we regard them as concretionary masses shifted, squeezed, and polished by the "creep" of the beds. Specimens of these may be got by hundreds in the nodular white chalk between the Archcliff and Shakespeare tunnels at Dover, and from the grey chalk of Abbot's Cliff and the Pelter. In the upper white chalk in the cliffs near the castle at Dover, small planes of slickensides of a few inches in extent are of common occurrence, completely passing through shells such as terebratulæ, spatangi, and other fossils.

The marly veins in the white chalk containing fish-remains are often penetrated by numerous small slickensides.

It is curious how so acute and talented an observer as Mr. Ansted should have fallen into such an error.—EDITOR OF "GEOLOGIST."

MAMMALIAN REMAINS NEAR SALISBURY, &C.—SIR,—Having noticed from time to time communications from various correspondents respecting the localities in which mammalian remains have been discovered, and deeming that it is from the comparison and arrangement of the accumulated evidence of separate individuals that any important results will be derived, I have presumed to trouble you with one or two instances that have come under my observation.

The pleistocene deposits lying to the west of Salisbury, and exposed in several brick-yards adjacent to the road leading to Wilton, seem peculiarly rich in mammalian remains. During the past summer there have been obtained teeth of the leptorhine, and tichorhine rhinoceroses, the mammoth, red-deer, ox, a portion of the jaw of a tiger, with a tooth *in situ*, the bones of a diminutive species of rat, and the coprolite of a hyæna.

Fossils of a similar character to some of these have recently been discovered in the neighbourhood of Northampton. When excavating for the extension of the gas-works, a peaty gravel bed was exposed about sixteen feet below the surface, which contained abundant remains of deer, mammoth, and rhinoceros; associated with these were great quantities of dark discoloured wood, amongst which were recognised the oak, elm, and hazel—the nuts also of the last mentioned were very numerous.

The pleistocene deposits around Luton have recently been frequently disturbed, but as yet have yielded no remains of mammals, the characteristic fossils being water-worn fragments of belemnites, serpulæ, encrinites, and gryphææ, apparently derived from the lias. If you would kindly assist me by any information respecting the geology of South Bedfordshire, you would greatly oblige yours truly, SILEX, Luton.

TERTIARY STRATA AT PECKHAM RYE.—DEAR SIR,—Some notes having appeared in former numbers of the "GEOLOGIST," on the deposits on the south-east side of London, I may call your attention to a bed which has been met with in excavating the high-level sewer at Peckham Rye. The deposit is about eight inches in thickness, and consists in part of a hard argillaceous limestone, in which are embedded layers of paludinæ, with occasionally traces of a large bivalve, which I believe to be a unio.

The other portion of this deposit, which is not so hard, contains melaniæ and cyrenæ resembling those from Charlton, together with oysters and fresh-water mussels with the nacre preserved. I have other shells from this deposit which I cannot name—one in shape resembles the marine mussel.

I have not been able to make a section, but I believe that this bed is situated beneath forty or fifty feet of clay. The sewer at this spot was nearly filled up when I last visited it, but shells may be obtained from the heaps thrown out at the side. I observed no pebbles or sand, which are so common at Woolwich and Blackheath. I should feel obliged to any of your readers, who may have visited this place, for information as to the position and correlation of this bed, and also whether any remains other than shells have been found there. A friend informs me that he has found the elytron of a small beetle in the limestone.—Yours truly, C. Evans, Hampstead.—Some few spines and very fragmentary portions of fish have been collected.—Ed. Geol.

Supposed Traces of Human Manufacture.—Sir,—The very interesting question which has been opened up lately by the discovery of implements of human manufacture in the drift beds of Amiens, Abbeville, and other places abroad, reminds me of a very curious relic, apparently of an exceedingly remote date, which was stored up in the Museum of Natural History at Derby when I paid a visit to that interesting collection, rather more than six years ago (August, 1853). It was nothing more nor less than a very antique-fashioned smoking-pipe, which had been found in connection with fossil bones in undisturbed strata at a depth of sixteen feet or more beneath the surface of the soil (if I mistake not) in the neighbourhood of Derby. This relic of a bygone age was, from the extraordinary position in which it was found, regarded by its discoverer as of very remote antiquity, and the placard which was written over it to attract public observation was not unnaturally worded "Geological Problem." From the pencil memorandum I made in my pocket-book, I find that it was accompanied by the following explanation in a letter addressed to the curator of the museum:—"I send you a geological problem. The accompanying tobacco-pipe was found in the Blue Band, the same stratum that contained the bones, &c. It lies sixteen feet deep, and is nine inches thick. It has gravel above and below. The pipe is not of modern manufacture. I hear that similar pipes have been found near Gainsbro'.—Yours, dear sir, F. J. Jessop. To J. Jones, Esq."

Of course, if the undisturbed condition of the strata could be proved with regard to this relic, it could not have been used for the purpose of smoking tobacco; and if my memory serves me right, there was no appearance of oleaginous carbonization in the pipe which could indicate that it had been so used, but possibly it may turn out that this rude instrument had been employed for smoking some narcotic herb, for Herodotus makes mention of the fact that a Scythian tribe were in the habit of exciting themselves by the smoke of some vegetable production. It is not unlikely that the art of smoking was practised long antecedent to the discovery of the "narcotic weed" *par excellence*. Perhaps some of your readers living in the neighbourhood of Derby may be able to give you further particulars about this alleged geological problem, or if not, the mere reference to the finding of other human implements than the rude celts of flint in positions evidencing great antiquity of deposit, may lead to the mention of many similar discoveries in different parts of the world.—I am, Sir, yours very truly, Francis F. Statham, F.G.S., Walworth.

Implements in the Drift.—From a note which I made at Beauvais, in the summer of 1858, I find that the museum of that city contains several specimens of rude flint tools of the same kind as those found at St. Acheul. I made a sketch of one of them at that time, to record the difference between these and the ordinary celts, though I was then unaware of any difference in their

origin. I also noted some flint knives, and some other thin cutting implements with regular serrated edges, which I took to be prototypes of saws. In addition to these ante-celtic remains, their are several instances derived from the contents of barrows of flint "urchins" being treasured up as sling-stones. I beg to suggest an examination of the local museums where such remains may be expected to occur, and a reference to the locality where found, if given. In the museum of Le Puy, I saw one of the flint tools which M. Aymard subsequently told me came from Perigueux, where a manufactory of them had evidently been discovered.—S. R. PATTISON.

THE DISCOVERER OF THE PTERASPIS REMAINS IN THE LOWER LUDLOW BED ("GEOLOGIST," vol. iii., p. 26).—We have received a communication from Mr. J. E. Lee, of Caerleon, inclosing certain letters from Mr. Lightbody to himself, in relation to the discovery of these interesting fish-remains. It is manifestly impossible for us to know the minutiæ of every geological transaction, but it is always within our province, and certainly agreeable to ourselves to become the means of correcting any of those accidental errors which will occasionally occur. In the case of these Pteraspis remains, it appears Mr. Salter, in the Annals and Magazine of Natural History for July, 1859, has doubtless most unintentionally committed the error of attributing their discovery to Mr. Lightbody, who forwarded them to Mr. Salter for examination and description, instead of to Mr. Lee, who really found them in the "starfish quarry" at Leintwardine, when collecting fossils there in company with Mr. Lightbody. Errors of this kind are much to be regretted, as the chief reward of the labours of provincial geologists is in their due appreciation and acknowledgement by the special authorities to whom they communicate, lend, and often give their most prized treasures, and in the present case it seems to be particularly unfortunate, as the specimen has been liberally presented by Mr. Lee to the Jermyn-street Museum, and duly acknowledged by Sir Roderick Murchison to him.

SLICKENSIDES.—In the last number of the "GEOLOGIST," page 38, line 6, for "George Hilliston" read "George H. Morton." See Note on Slickensides.

REVIEW.

Geology in the Garden. By HENRY ELEY, M.A. London: Bell and Daldy.

"Geology in the Garden" is a pleasing idea; it suggests at once the simple plan and story of the book, but we scarcely thought when we opened it the garden would have given so wide a range—so much scope of subject available for so much instruction as Mr. Eley has made it convey.

Walking round his garden, one sees two prominent subjects of inquiry—the gravel of the walks, and the soil of the beds. The gravel derived from the flints of the chalk contains microscopic and other cretaceous fossils, which of course are fully described. For the most part they consist of Foraminifera; and Mr. Eley's original observations and remarks upon that wonderfully diversified class of simple rhizopods do him high credit for acuteness of investigation and perspecuity of explanation. The other topic—the soil of the beds—is handled with considerable skill, and attention is admirably directed to the powerful influences exerted by earthworms in assisting the waste by rainfall and other denuding operations. One extract on this topic will bring a valuable consideration home to many of our readers:—

"As the worms desert their old burrows, the soil sinks in and fills them; and by this means a constant circulation is continued, the vegetable mould extending itself downwards, while the 'dead soil'—that is, the purely mineral matter—is brought up, and so the cultivable staple increases. If we examine even the unmoved gravel in the pit, wherever it is not too deep below the surface, we shall find that the worms are invading it, eating out the sand between the stones, running their excavations down in favourable places, plastering them, too, round the sides with the peculiar slime and earthy matter with which they puddle them to keep out the wet, and leaving their excrement in them; thus gradually changing the colour of the mass, and making it fit for the roots of the herbage above to strike into.

"It is believed to be a mistake, however, to suppose that the growing vegetation is supported chiefly by vegetable decay. A certain essential portion of its carbon—that is, its vegetable matter—the rising plant, it is thought, must thus obtain; but it is dependent upon the atmosphere for its chief supply, having the power of elaborating carbon from it by means of its leaves. What the plant specially wants from the soil is mineral matter; and this the earthworm keeps within its reach, by continually transferring it from below upwards, in a properly comminuted state. Every shower that falls washes away some of this valuable matter, as anyone may see who will watch the rills which trickle over the surface at the time; and if the rain is heavy, it carries off a great quantity of clay and sand. The unavoidable consequence of this natural operation would be that the upper layer would consist chiefly of the coarser materials, the larger grit and stones, which would be ill adapted for the support of the more valuable kind of herbage. But the earthworm supplies the waste; and in this way is an agent of which geology must take notice; for denudation and its consequences—the filling up of valleys and lakes, the growth of deltas at the mouth of rivers, and the accumulation of strata on the sea-bottom—would all go on more slowly if the worm did not bring up fine matter to the surface for the rain to sweep off."

We have not space in this number to notice very minutely Mr. Eley's book; and indeed it is not essential that in reviewing we should descend into particulars. It will suffice then to add a plan of the work. From the flint-pebbles in his garden our author passes to a consideration of the Chalk formation and the great physical changes to which the Wealden area of the south-east of England has been subjected.

In treating of the origin of those remarkable bands of siliceous nodules which mark the upper beds of our English chalk, however, Mr. Eley throws no additional light, and leaves that difficult question as he found it.

From the physical events of this region we are passed on to the boulder-drift and to still more expanded views of the general physical conditions of our globe itself. Then are so naively brought forward the habits and operations of the earth-worm to which we have so pointedly alluded. The concluding chapter developes the author's view that the changes indicated by Geology reveal part of a fore-ordained plan for preparing the earth's surface for the occupancy of man. For ourselves we have derived both pleasure and instruction from Mr. Eley's book, and there are but few which it has fallen to our lot to read, that we could recommend to our readers so sincerely, or with so much pleasure.

THE GEOLOGIST.

MARCH, 1860.

GEOLOGICAL LOCALITIES.—NO. I.

FOLKESTONE.

(Continued from vol. iii., *page* 45.)

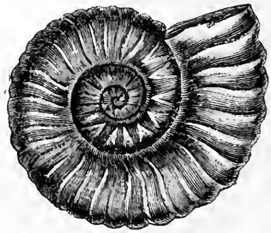
BY S. J. MACKIE, F.G.S., F.S.A.

SLOWLY the calm sea ebbs. As the pulse of the great ocean beats, its glassy ribbon-waves flow swellingly along in long thin lines, and then drain rapidly away. Every now and then, with higher swelling motion, one wavelet ripples further in, leaving us doubtful for a moment of the tide's recess. But gently, surely are those slippery rocks unveiled, and on their smooth and purple flats the glittering fossils lie.

Lign. 3.—*Ammonites Lautus.* From the Gault.

There, in their radiant iridescence in scores are pearly Ammonites. *A. lautus*, *A. splendens*, *A. auritus*, *A. tuberculatus*, and the little ribbed and everywhere bestrewn *A. varicosus*.

There hundreds of amber-like translucent Belemnites (*B. Listeri*) protrude their spine-like forms from the dark blue solid clay.



Lign. 4.—*Ammonites varicosus.* From the Gault.

Curled Hamites, small nut-shaped Nuculæ (*N. pectinata* and *N. ovata*), spiny Rostellariæ, Pterocera, and Naticæ, and black phosphatic casts of antique forms of crabs and prawns, and little stud- and cup-like corals await your gathering. Everything to your

Lign. 5.—*Ammonites tuberculatus.* From the Gault.

hand, resplendent as the sea has left them for you. Every here and there the smallest portion of some shell or crab reveals the untouched treasure buried underneath. Pick, trowel, knife, anything will dig into that moist yielding clay, or cut your treasure out. Patience and care are all you want.

It was a treat indeed in my youthful times to see that "fossil-bank" uncovered, and display its myriad treasures. Sacks full of

Lign. 6.—*Ammonitus auritus.* From the Gault.

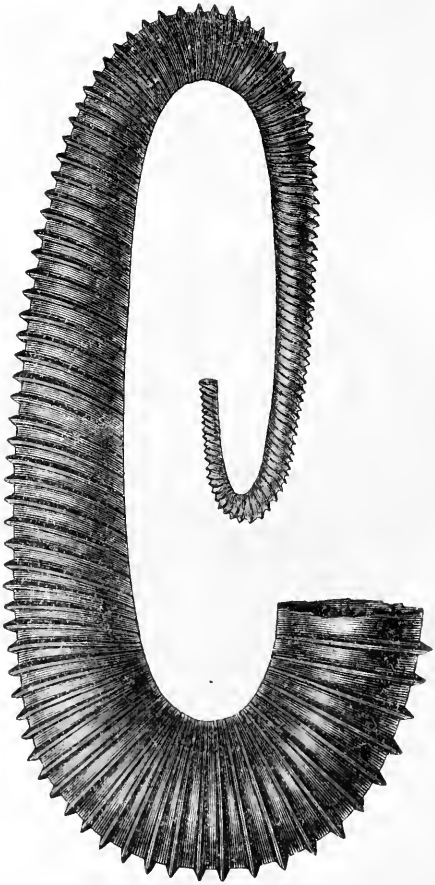
beautiful fossils would repay your inter-tidal toil; but now, daily is that restricted tract most keenly watched by searching eyes; and

Lign. 7.—*Rostellaria Parkinsonii.* From the Gault.

scantier every day becomes the harvest to be gathered. Not so Copt Point: here, after winter storms and snows, tons of the shivered clay

are launched from time to time, and offer to the searcher rich rewards.

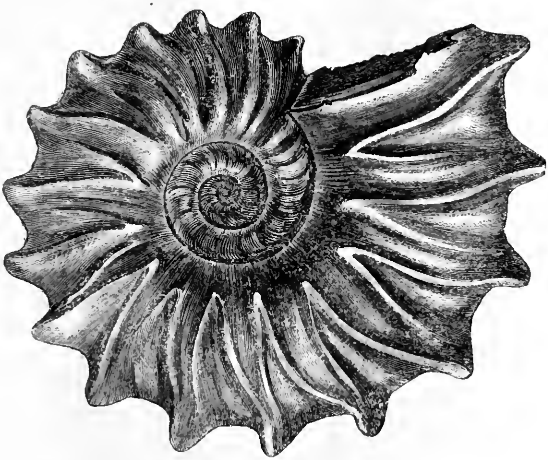
Curious too, indeed, in its geographical range is this tenacious belt of dark blue clay. For miles and miles the narrow band ex-



Lign. 8.—*Hamites rotundus.* From the Gault.

tends along, marked to the eye in winter by its moist and spongy verdure, in summer by the arid browns of its scanty herbage and its cracked and fissured soil. All along its course grow stunted oaks;

and ever and anon brick-works and tile-kilns, like signal posts, stand out upon its tract. All round the chalk-hills, in their extended semicircle-range, and again on the shores of the Gallic lands across the "narrow straits," through Dorsetshire, through Cambridgeshire, ever cut off from the white chalk hills by a green sandy belt (the Upper Greensand), sometimes developed into thick courses of sand and firestone, as in Surrey and the Isle of Wight, sometimes only a narrow dark green bed measurable in inches, as in Eastwear Bay, and cut off from the beds below—the Lower Greensand and Neocomian—by a stratum still more remarkable in its characters, value, and origin.



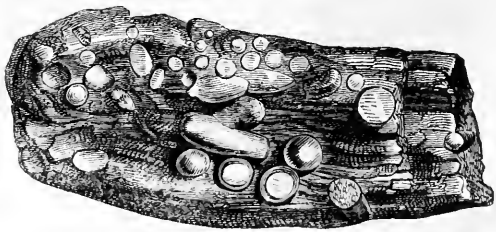
Lign. 9.—*Ammonites interruptus.* From the "Ammonite-stratum" of the Gault.

Near the base of the Gault there streams along a single narrow layer of broken casts of largish ammonites.* Once measuring the distance from the basement-bed above referred to, or, as for years I have rather called it, the "junction-bed," with the handle of your pick, or any other ready means, strike where you will along the encrusted, or debris-covered face of the cliff, there surely will your pick's point clatter against those hard and rugged nodules. There they

* These casts are chiefly those of *Ammonites Benetianus*, with a smaller proportion of *A. interruptus.*

are as sure as fate, and in one narrow seam. Not many in kind, two, or at most three, are the species whose remains are thus spread over geographical tracts, expressible only in square miles. Myriads of them must have perished to have formed this one tesselated floor of the old Cretaceous sea. And here, gentle reader, is a mystery for you to solve, or ponder on. Whence came these sharply broken casts? What current, or what force of ocean-water spread them like road-metal, as it were, o'er the old sea-ooze?

But lower down again. I long to point you out that "junction-bed." Mystery of all mysteries along this coast is the mystery there. But there it is, solid and hard, about eighteen inches thick, jutting out beyond the clay above and sand beneath—red, yellow, brown, and black—glittering with metallic pyrites (sulphuret of iron) and seamed with glassy crystals (selenite—sulphate of lime) there is that curious conglomerate of rounded potato-like lumps of phosphate of lime and scraggy gnarled boughs of trees. The gnarly boughs do



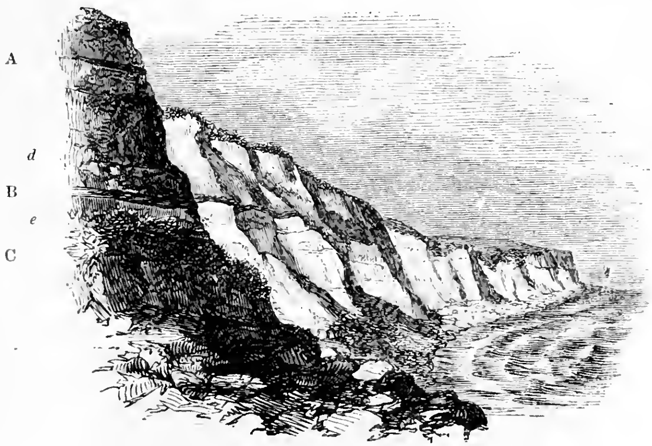
Lign. 10.—Fragment of Dicotyledonous Wood bored by Teredo. From the "Junction- (phosphate of lime) bed," at Copt Point, Folkestone.

tell us something; riddled through and through by Fistulana and Teredo, they speak most eloquently of their stormy wanderings over the sea. But those round phosphatic lumps, what do they teach us?

"The sculptured stone, or the emblazoned shield often speaks when the written records of history are silent. A grotesque carving, coat, or badge in the spandril of some old church-door, or over the portal of a decayed mansion often points out the stock of the otherwise forgotten patron or lord. A dim-looking pane in an oriel window, or a discolored coat in the dexter corner of an old Holbein may give not only the name of the benefactor, or of the portrait, but

also identify him personally by showing his relations to the head of his house, his connections and alliances."

So with the geologist: when petrological conditions, chemical analysis, or microscopic investigation fail at first to give the clue, we may still find the key to the solution of a physical fact in the evidence of some simple, even it may be some obscure thing. But the key to the geological history of this valuable band of mineral manure has not yet been found. There, however, is that narrow seam of

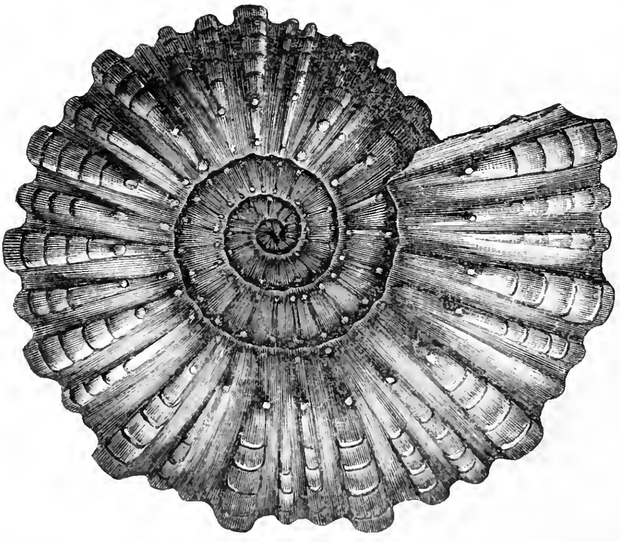


Lign. 11.—Copt Point, from the East Pier of Folkestone Harbour.

A, *Gault.* *d*, Stratum of phosphatic casts of *Ammonites Benetianus.* B, "*Junction-bed,*" composed of nodules of phosphate of lime, with casts of *Ammonites mammilaris* and gnarled pieces of wood, bored by Toredo. C, *Lower greensand.* *e*, Stratum of small phosphatic casts of *Ammonites mammilaris*, bivalves, and Dentalia.

rounded nodules, offering 40 per cent. of fertilizing phosphate, persistent everywhere with the gault itself. All round the chalk-downs, in their range from close by this point on which now we stand, through garden-like Kent, and past the charming rustic hamlets of beautiful Surrey to the bleak Sussex coast have I, walking through green refreshing lanes and over stubbled fields, traced out this fertilizing band. On the northern shores of France, between where the now forsaken but once active port of Ambleteuse presents its pierced and mouldering piles, and Wissant, the gault again comes out to view, and this narrow sombre-coloured junction-seam again is there.

What is its history? Bones of animals, we know, are formed of phosphorus and lime (phosphate of lime), but not a trace, save rarely a few teeth of sharks or tiny vertebræ of fish, of bones of any living thing of earth, or air, or sea is there—so far as we can see; and yet there are tons and thousands of tons of what we only know in an organic form as bone-substance. There are the gnarled riddled boughs of trees, charred into radiate blackness in the lapse of incomprehensible time, and these are rich in, nay, permeated, soaked, so to speak, with the phosphatic matter, for they offer to the chemist's test as much per cent. as these hard, black-brownish lumps. There are broken phosphatic casts of the rough rugged *Ammonites mammilaris*



Lign. 12.—*Ammonites mammilaris*. From the "Junction- (phosphate of lime) bed."

in numbers, bedaubed and patched with phosphatic concretions, but nothing else, save of shell-fish a few stray straggling Inocerami or Dentalia, which only occasionally occur.

These phosphate-nodules, I should think, must have been derived from some organic substance, the great accumulation of which at one horizon, however, is very remarkable. Could the perishing carcases of gigantic Ammonites, such as the *A. mammilaris* in its adult

state, or the myriad swarms of smaller cephalopoda have furnished the fertilizing phosphate? I know of nothing to justify this idea, unless the phosphatic pellets we not uncommonly find in juxtaposition with the little Belemnites of the gault are the shrivelled bodies of the cuttle-fish, whose internal supports they were. That which seems to me probable is that this remarkable band derives its origin from the organic *débris* of a great ocean, very clear of mineral sedimentary matter, during a long period of time; or, that when the alteration of physical condition took place, by which the sandy deposits of the Lower Greensand were exchanged for the muddy condition of the Gault, a deposition of organic *débris* took place, derived from the destruction possibly of a part of the fauna of the Cretaceous sea, by the influx of unfavourable currents, or from the washing in to its area of some previous accumulation of the decaying substances of some coastal region.

Be this as it may, the subjacent greensand, comparatively free from calcareous or argillaceous matter, indicates the clearness of the water in which it was deposited; and when the cessation of its deposit took place, the mineral characters of the Gault shew that it derived its origin from a very different source. Between the periods of these two deposits is it unreasonable to suppose an interval of local quiescence and freedom from any of the wasting operations which produced the sedimentary materials of the Gault and Greensand to have taken place, during which the organic matter of the Cretaceous sea fell to the bottom, to form in future ages a vast store of mineral manure.

How unconscious of all this was the ornamented ammonite, sporting in its glittering shell, or the teredo boring the drifting wood. When we think how the dead and putrid things falling in the ocean's depths in after ages may be changed into bread—how rich in treasure is the slime and bottom of the deep; when we think that in the silent waters, dark and deep, myriads of toiling creatures were at their busy work millions of ages since; when we look through the long vista of time, and contemplate the changes that probably have happened to the little clot of earth that forms our muscles, nerves, and bones; when we think that the gay and scented flowers might have been once the refuse of the deep, and that in the changes of

matter the very dregs of earth may become redolent with life and beauty, our thoughts turn in reverent homage to the great planner and preserver of all things, by whose sometimes inscrutable, but always benevolent laws, the order and endurance of creation is maintained.

(To be continued.)

ON THE SOUTH WALES COAL-FIELD.

By G. P. Bevan, M.D., F.G.S.

As the season for active out of door geological work is now approaching, I propose to give a brief glance at some interesting features of the South Wales coal-field, in the hopes that pedestrian geologists may be tempted to make it one of the scenes of their labours. And they will be richly rewarded; for, though coal-fields generally give us an impression of a black, unsightly country, without vegetation or anything pleasant for the eye to rest upon, they are not all alike, and that of South Wales is as rich in beautiful scenery above ground, as it is in the precious mineral beneath. Glorious hills intersected by narrow valleys and wooded dells, each washed by its mountain-stream, and antiquities—in the shape of castles, abbeys, cromlechs, and cairns, may tempt the tourist to whom geology does not hold out sufficient inducement. It is in outward features, which I shall first touch upon, that this differs so much from other coal-fields, the basin being more clearly marked, and the underlying grits and limestones, being more uniform in their development than in any district in Great Britain. Indeed, it is only in two places that the regularity of the basin is broken, viz., between Newton Nottage and the Mumbles, and at Llanelly, in Caermarthenshire, and then solely because the coal-measures run under the respective bays of Swansea and Caemarthen. The basin, however, is not altogether round, but of an irregularly oblong shape, caused by the north and south boundaries approaching each other towards Pembrokeshire. The

cause of this, we are told,* has been a strong lateral pressure, acting unequally, or meeting with unequal resistance, after the accumulation of the Old Red Sandstone, and probably of the Coal-measures, the effects of which are principally seen in the counties of Pembroke, Caermarthen, Glamorgan, Monmouth, Brecon, Hereford, and Worcester; and not only has this pressure conduced to the outward shape of the basin, but, as we shall presently see, to the peculiar troughs and anticlinals within the basin.

Over the greater portion of the district, hill and dale succeed each other with wonderful regularity, causing one valley to resemble the other so much that it is frequently difficult for the stranger to ascertain his whereabouts; but this applies more particularly to Monmouthshire. From the table-land of millstone-grit and limestone on the north, issue a number of small streams running due south to the Bristol channel, at an interval of from four to six miles. From east to west we have first the valley of the Afon, followed by those of the Ebbw Fach and Fawr (Little and Great Ebbw), succeeded by the Sirhowy and Rhymney rivers, all of which converge, and have their outlet at, or near Newport. We then cross the Taff into Glamorganshire, where a change takes place in the physical features. There are still valleys and hills, but the valleys are broader and of more importance, while the hills are more irregularly placed, and grouped in more picturesque fashion. We have now two sets of valleys running in different directions: first, that of the Taff with its feeders of Aberdare and Rhondda, finding their terminus at Cardiff; but west of the Taff we find ourselves in the most mountainous portion of Glamorganshire, in which the hills are of great height, and the valleys become mere dells: the principal of this set are the Llynvi, the Ogwr, and the Afon, the two first of which find their outlet at Bridgend, and the latter at Aberavon. Secondly, turning to the north, we find that from the same table-land which gives birth to the Aberdare valley, issues the beautiful Vale of Neath, running to the south-west, an important alteration in the physiognomy of the county. All the subsequent rivers follow nearly the same arrangement; for west of the Vale of Neath we have that of the Tawe

* Memoirs of the Geological Survey, vol. i., page 224.

or the Swansea valley, followed by the Lloughor and Gwendraeth rivers, which have their respective outlets at Llanelly and Kidwelly.

In whatever portion of the field we make our observations, we cannot help being at once struck with the effects of the enormous denudation to which it has been subject. The great pressure, or catastrophe, has been shown by Prof. Ramsay to have probably taken place at the close of the coal-measure period, and did not consist of a number of detached efforts, but of one gigantic contraction. The effects were to create tremendous flexures and contortions of the strata; and, if such are not always visible to us, we must remember that the lower beds were saved from the shattering influence by the immense super-incumbent weight of strata which has been long ago worn away by denudation.

The greater part of this denudation happened in Tertiary periods, and was almost exclusively the work of marine action, as Professor Ramsay shows that fluviatile forces or atmospheric influences, although doubtless contributing much to the general appearance of the country, had but little power to cause such extraordinary effects. We can well understand how it is that most of the tops of the hills are crowned with hard rock, such as Pennant grit, having from this cause been able to resist the denuding force of the sea. If we examine the measures underground, we at once see the results of the pressure to which the field was subject. It is generally spoken of as an elongated basin, or trough; but the real fact is that there are two troughs running east and west, the smaller one being parallel to the larger, and separated from it by a considerable ridge, or anticlinal axis. The main trough contains by far the greater portion of the measures, which of course basset north and south. The centre of the big trough runs underneath Newbridge (Monmouthshire), through the high ground into the Sirhowy valley, below Blackwood, then into the Rhymney valley, which it crosses at Craig Penalltau, and under the Gellygaer Hill, into the Taff Vale at Navigation.

From thence it extends to Llanwonno, and through the Rhonnda valley, into that of the Afon. Curiously enough, as far as Gellygaer, the course of the trough underground corresponds closely with that of the Taff-Vale extension railway above ground. Newbridge in Monmouthshire is at the centre, or deepest part of the trough; while

Newbridge, in Glamorganshire, otherwise called Pontypridd, is situated on the anticlinal axis, which has the effect of bringing up the lower measures at Maesteg iron-works in the Llynvi valley. It is marked by the appearance of a rock termed the "Cockshort Rock," which consists of a bed, or beds, of sand, consolidated together so as to form a quartz-rock: by miners it is known in some districts as "carreg," or "craig gwenith faen"—the wheat-grained stone, and is important as being the only white quartz-rock in the field; it is a serviceable guide to the relative position of certain beds of coal. Its course is from Baglan, near Briton Ferry, to Cwm Avon, Maesteg, Braich-y-cymmer, across the Llangeinor Mountain, Cilley, and Newbridge, to the Eglwysilan Mountain. We find the trough again, although wonderfully narrowed at the western end of the field, at Llanelly, Caermarthenshire. The smaller trough is directly south of the larger one, and in fact occupies all the distance between the great anticlinal axis and the southern crop of the basin. As a consequence, the beds of the south crop are much more highly inclined than those on the north. They are also of much greater thickness, showing a progressive tendency to thin-out as they approach their northern limit.

The faults of the South Wales field are numerous, and often locally extensive, though there are none of general magnitude like the Ninety Fathom Dyke. The largest faults are to be found in the north-eastern part of Glamorganshire, running south-west from Merthyr, across the Gellygaer-hill to Llancaiach, where it is one hundred yards, so that the Mynyddswlyn-vein of coal, which is worked by level at Tophill, is obliged to be worked by deep pit at the Llancaiach Colliery, only a few hundred yards to the south. Another great fault, runs westward from Trevethin, near Pontypool, to Blackwood, where there is a perfect chaos of faults, the appearance which on the Geological Survey's map reminds one strongly of Bradshaw's Railway-map. The whole of the south crop is much intersected by faults, particularly in the west of Glamorganshire and Caermarthenshire; but their small size prevents their having any general interest. Nevertheless, it is highly important that even small faults should be duly chronicled, for many instances might be recorded where ignorance of existing disturbances has caused a

serious loss, and even ruin to a colliery proprietor. This is particularly of consequence in the present day when speculation is rife, and new pits and levels are opened every month, often by persons who have no practical acquaintance whatever with mining affairs. It is, therefore, the interest of everybody having mineral property to use their best endeavours, not only to develope the knowledge of existing faults in the strata, but also to correct present inaccuracies.

There are few coal-fields in which the Lower Measures can be so conveniently studied, on account of the large area over which they are spread, their extreme regularity, and the generally gentle angle at which they crop out. This, however, does not apply so much to the measures of the south crop. The Middle and Upper measures are by no means so generally to be found, owing to the extensive denudation that has been shown to be carried on in subsequent ages to their deposition. As they are chiefly found in Glamorganshire and Carmarthenshire, I will first confine myself to the eastern or Monmouthshire district, embracing from the Pontypool valley to that of the Taff. The mountain-limestone of the Blorenge forms the western boundary of the coal-field, and is a prominent object for many a long mile, commanding as it does views of the Old Red which lies at its feet, the Silurian upthrow of Usk, and the woods of the Forest of Dean, with the Channel and the Somerset hills as a background to as lovely a view as any in England. In a break of the hills, through which the Afon emerges, Pontypool is situated, a town with the usual amount of busy population and dirt which is displayed in the iron-work districts. Nevertheless, it is honourably mentioned as being one of the very first seats of the iron-trade which was commenced in 1560 by an ancestor of the present Lord Lieutenant, one Richard Hanbury, a worthy goldsmith of the city of London, who used charcoal furnaces. Charcoal was generally employed for smelting prior to the discovery of coal, and many of the neighbouring hills, now bare, were evidently once upon a time covered with timber which was cut down to supply the trade. At the time of Mr. Hanbury's undertaking, the whole of the mineral property was let for nine shillings and fourpence, the rental now showing a value more like that of house-room in London.

I will not weary my readers with a full list of all the measures here, with their accompanying shales, sandstones, and iron-ores,* suffice it to say that there is an aggregate thickness of forty-six feet of coal between the Pennant rocks and the millstone-grit. I will first run over the names of the more important seams, for the purpose of identifying them with those in other valleys. In no district in the world probably is there such a hopeless confusion of nomenclature as regards the coal-measures; one valley sometimes differing altogether from the next in the names of what are precisely the same seams. It may be easily imagined that difficulties may thus be thrown not merely in the way of geological science, but also in the identification of measures in different parts of the basin.

The principal seams at Pontypool are as follows:—

	Ft.	in.
Mynyddswlyn Vein	3	0
Troed-y-rhiw	2	0
Coal	3	0
New Vein	4	0
Red Vein	2	6
Rock Vein	7	6
Yard	2	6
Meadow Vein	4	6
Stone Vein	4	0

The Troed-y-rhiw coal is the highest in the lower measures, and occurs also at the base of the Pennant-rock; there is, nevertheless, a considerable amount of sandstone generally found between it and the next vein. Its general thickness is not great, seldom above two and a half feet, but in all the valleys it is much worked under different names, owing to its accessibility and its constancy of position. Thus the Troed-y-rhiw coal of Pontypool is called at Abertillery the Cwmtillery or Tilestone-coal; in the Cwm Carne, the Pontgwaithairarn; in the Ebbwvale valley, Noed-y-rhiw; and in the Rhymney valley, the Brithdir.

Above this coal lie what in Glamorganshire would be called the middle measures, but which in Monmouthshire is simply unproductive sandstone, known as Pennant rock; at Pontypool it is about eight hundred feet thick, and immediately above it lies the only

* They will be found in the Memoirs of the Geological Survey, vol. i., page 174.

upper-measure seam east of the Taff. The Mynyddswlyn-vein, three feet thick, is the great vein from which the red ash, or home-burning coal is sent to Newport and Cardiff. It occupies a rather narrow tract of country, runing east and west from Pontypool to the Taff. The railway which goes across Cwmlin Bridge takes us through the very centre of this tract, which is very thickly studded with collieries, and cut up with a number of small faults A good idea of it will be gained from the horizontal section of the Government Survey, No. 12, as it runs through the Cefn Crib mountain to crop out at Cred Colynos, above Pontypool. It usually consists of a top- and bottom-coal, divided by a varying amount of rubbish, or parting—for instance, at the south-east crop of this vein, which is to be found at the Penner colliery, near Newbridge, the division is thirty-three feet thick; but on the north crop, at Tophill, near Llancaiach, overlooking the Taff Vale, it is only a foot and a-half; so that the two veins can be conveniently worked together. I append a section of this coal as worked at the Mamhole-colliery, in the Sirhowy Valley, the property of Sir. Thos. Phillips:—

	Ft.	in.	
Surface	19	6	
Rock	33	0	
Clod	8	0	
Thin coal (The Rider)	1	2	
Clod	30	0	
Rock	54	0	
Clod	30	0	
Coal (top)	3	0	Mynyddswlyn
Clod	1	6	Mynyddswlyn
Coal (bottom)	2	6	Mynyddswlyn

The clod soon begins to thicken, even in the space of a few hundred yards, as does the coal itself.

From the measures at Pontypool several coal-plants have been obtained; but the most interesting fossil there is found in the ironstone, just above the Meadow-vein. It is the *Productus scabriculus*, the only Productus ever found in the true coal-measures, and as far as I have been able to ascertain, the only specimens as yet found in the district. Here they are very plentiful.

As we follow up the Afon and Frwd valleys we successively arrive

at Abersychan, Varteg, and Blanafon works. At Varteg, the coal thickens out to an aggregate of fifty-one feet, the Rock-vein, which is here called the "Droydeg"-vein, thinning to six feet five inches, and the Meadow-vein increasing to seven feet. At Blanafon the former is called the "Bydellog"-coal, a name which it keeps until we enter Glamorganshire; while the latter is the equivalent of either the Pwltacea, or the old-coal, most likely of the first.

Here we turn the corner of the basin, and proceed eastward, the measures rounding the Ganerew mountain into the Clydach valley. Of this beautiful dingle I need only mention that the scenery will amply repay any visitor, being equal to many parts of Derbyshire. Here, too, were the first specimens of the Stigmaria observed and described by that intelligent old philosopher Lhwyd. Good coal-plants can be easily obtained at all these works at the expense of a little trouble, though it is always as well to apply first of all to the underground agents, who are generally glad to afford information. The valleys of the Ebbw having been already described in the "GEOLOGIST," vol. i., p. 119-124, I need not touch upon them any further, but pass at once through Nantygls, Beaufort, and Tredegan into the Rhymney-valley. Along the whole of the road good sections of the bottom-veins are constantly to be met with, and in many of the "tips" are plenty of fish-remains and Anthracosiæ (principally *A. agrestis*).

Above Rhymney Gate, in the bed of the river, is the most prolific shell-bed that can be imagined, lying in the "Farewell"-rock, just above the millstone-grit. This is the horizon of the marine shell-bed which runs from Beaufort into Camarthenshire. The principal veins worked at Rhymney are—

		Ft.	in.
	Elled	4	0
Equivalent to the three-quarter coal of Nantygls and Ebbw-vale.	Upper Four-foot	3	1
	Big Vein	4	10
Equivalent to the Droydeg of Vartes, and Bydellog of Ebbw-vale.	Ras-las	5	8
	Thee coals	2	4

		Ft.	in.
Equivalent to the Stone vein of Pontypool and old coal of Ebbw-vale.	Lower Four-foot	6	5
	Yard Vein	2	0
	The aggregate being about	48	0

Many good fossils have been obtained from these measures, the "Elled coal" yielding numerous plants, as it does also at Blaina and Beaufort; while many of the veins of iron-ore abound in shells, principally *Unio aquilius* and *U. centralis.* I must not forget to mention a small seam of coal, seldom above two feet thick, which lies immediately above the "Farewell"-rock, and is the most constant seam in the whole basin. It is known at the different works as follows:

		Ft.	in.
Pontypool	Little Coal	1	6
Varteg	Brass Coal	1	0
Blanafon..............	Engine Coal...........	2	4
Nantygls	Big Vein	1	6
Beaufort	Big Vein	1	6
Blaina..................	Little Vein	2	0
Ebbw-vale	Bottom Vein	2	0
Rhymney	Rough Pin Coal	1	4
Dowlais	Lumpy Vein	1	3
Hirwain	Knobby Vein	1	6
Onllwyn	Cnapog Coal	1	6
Yniscedwin	Clas-vach Coal.........	2	6

In most of these places it is characterised by fish remains, and, indeed, almost every specimen I have (from six or seven species), have been found in this coal, showing that they were not of mere local occurrence, but were general over the whole field at this period of the coal-era. This will account for the fact that hitherto I have not heard of any fish in the upper measures.

The scenery as we journey down the Sirhowy and Rhymney valleys is very wild and picturesque, and but little spoilt by the collieries which, as a rule, are planted on the high grounds between the valleys, working the Mynyddswlyn-coal. Of course no tourist,

geologist or not, will quit the latter valley without visiting the castle-city of Caerphilly, with its leaning tower, the most stupendous ruin in South Wales, which we are told contained within its walls, at the time of the memorable siege in the reign of Edward II., "two thousand fat oxen, twelve thousand cows, twenty-five thousand calves, thirty-thousand sheep," as food for the garrison.

THE CARBONIFEROUS SYSTEM IN SCOTLAND CHARACTERIZED BY ITS BRACHIOPODA.

By THOMAS DAVIDSON, Esq., F.R.S., F.G.S., Hon. Member of the Geological Society of Glasgow, etc., etc.

(Continued from Vol. iii., p. 25.)

FAMILY STROPHOMENIDÆ.

This family, which has been termed *Orthidæ* by some authors, comprises several genera and subgenera, of which *Strophomena*, *Streptorhynchus*, and *Orthis* alone have been found represented in Scottish Carboniferous strata.

GENUS ORTHIS. Dalman. 1827.

The genus *Orthis* forms a well characterized group, especially specifically numerous and abundant in the Silurian and Devonian systems, is considerably reduced during the Carboniferous period to appear no longer (?) in subsequent stages. Two species alone have been hitherto discovered in the Carboniferous rocks of Scotland.

XXII.—ORTHIS RESUPINATA. Martin. Pl. i., fig. 11-15.

Conchyliolithus anomites resupinatus. Martin, Petrif. Derb., pl. xlix, figs. 13-14, 1809. *Terebratula resupinata,* Sowerby Min. Con., tab. 325.

In shape it is either transversely oval, or elliptical, but varying greatly in the convexity of its valves; some examples are moderately convex, others gibbous, hence the specific denominations of *resupinata, connivens,* and *gibbera,* which have been applied to what we must look upon as variations of a single species. The hinge-line is straight and shorter than the greatest width of the shell, with rounded cardinal angles; each valve possesses a small area, of which the ventral one is the largest, and divided in its middle by an open triangular fissure. The dorsal valve is always the deepest, and either regularly and evenly convex or slightly flattened from the middle to the front. The ventral valve is slightly or moderately convex at the rostral portion, but becomes flattened, or even, sometimes slightly concave as it approaches the sides or frontal margin. The beak is small, slightly prominent and incurved. Exteriorly the surface is closely covered with fine thread-like rounded radiating

striæ, which increase in number by intercalations, or bifurcations, at variable distances from the beaks; and at intervals the striæ themselves increase in thickness and prominence, giving birth to small hollow spinose asperities, or thread-like tubular spines, which augment in number towards the margin, but are broken close to the surface of the valves in the generality of specimens. The intimate shell-structure is also perforated by innumerable canals, of which the exterior orifices, in the shape of minute punctures, cover the entire surface of the shell.

In the interior of the ventral valve, the dental plates extend to some distance along the bottom of the shell, and between these a small rounded or angular ridge divides the muscular scars, which thus form two elongated depressions margined on their outer sides by the prolonged basis of the dental plates. The occlusor leaves a small not always clearly defined impression on either side of the mesial ridge, and it is probable that the larger impression named divaricator, and marked (R) in our figures 9 and 13 of *O. Michelini*, and *O. resupinata* is apparently composed of two parts, the anterior, or central, being the devaricator, while the other, the posterior, or lateral, which is parallel may belong to the ventral adjustor?

In the dorsal valve the fissure is almost entirely occupied by a moderately produced shelly, or cardinal process, to which were no doubt affixed the divaricator muscular fibres; the inner socket walls are sometimes somewhat prolonged under the shape of projecting laminæ, to the extremity of which free spiral arms may perhaps have been affixed, while under this shelly process, a longitudinal ridge, with a wide flattened space on either side, separates the quadruple impressions of the adductor, or occlusor muscles, these last producing two oval-shaped depressions, placed obliquely one above the other, and separated by lateral ridges, branching from the central ridge. Vascular impressions and ovarian markings are often clearly observable in the interior of both valves.

Orthis resupinata has sometimes attained two inches and a-half in length by rather more than three and a-half in breadth; but the largest Scottish example that has hitherto come under my observation did not exceed about one inch in length, by one and a quarter in breadth.

This shell occurs at Gare, in Lanarkshire, at two hundred and thirty-nine fathoms lower than the "Ell Coal," and three hundred and forty-one at Raes Gill. It is found also in the same county at Middleholm and Brockley, near Lesmahago; Capel Rig, East Kilbride; Netherfield and Gallow Hill, near Strathavon; and Robroyston, to the north of Glasgow. In Ayrshire, at Auchenskeigh, near Dalry; West Broadstone, Beith; Craigie, near Kilmarnock; Cessnock, near Galston. In Dumbartonshire at Castlecary. In Stirlingshire it occurs in several stages. At Balglass Burn, in the Campsie main-limestone, and Corrie Burn beds. It has also been collected in Arran, at Charlestown, in Fifeshire, and at Scola Burn, in Midlothian.

Prior to concluding our notice of *O. resupinata*, we must allude to certain specimens of a small *Orthis*, first discovered by Mr. Young, at Corrie Burn, and represented in our plate by fig. 15. This little shell was for some time considered by Mr. Young and myself as possibly a distinct species, but I am now disposed to believe it a young, or small exceptional shape, or variety, of *O. resupinata*, in which the area in either valve is unusually developed; the striation of the surface of the valves does not appear to differ from that of Martin's shell, and evidence of spines and tubercules may also be clearly observed. We will, therefore, provisionally at least, consider this small shell, with widely separated beaks as an exceptional shape, or variety, of *O. resupinata*.

XXIII.—Orthis Michelini.* L'Eveillé. Plate i., figs. 7-10.

Terebratula Michelini, L'Eveillé, Mem. de la Soc. Geol. de France, vol. ii., p. 39, pl. ii, figs. 14-17, 1835. = *Spirifera filiaria*, Phillips' Geol. of York., vol. ii., p. 220, pl. xi, fig. 3, 1836.

This Orthis is either circular or longitudinally subtrigonal, the greatest width being situated in the frontal half, while the front itself forms either a gentle outward, or a slight inward curve. The hinge-line is abbreviated, and at times does not attain one third the width of the shell; both areas are consequently very small; but that of the ventral valve is the largest, and divided by an open triangular fissure. The dorsal valve is moderately convex, with a gentle depression towards the front, while the ventral one is very shallow, slightly convex at the beak and along the middle, from whence it becomes much flattened towards the margins. The depressions of the ventral valve and slight convexity of the dorsal one give to the shell a general depressed appearance, which is one of the features by which it can be distinguished from *O. resupinata*. The beak of the ventral valve is small, slightly incurved, and projecting but little beyond the level of that of the dorsal valve. The surface of the shell is ornamented by numerous small radiating thread-like rounded striæ, which rapidly increase in number by numerous intercalations, while from all these little ribs numerous small hair-like hollow spines project, becoming more closely packed towards the margins, so that, when alive, the whole shell must have been invested with delicate spines, no where exceeding a quarter of an inch in length. Prof. de Koninck who, in 1843, first noticed the spiny investment, was of opinion that the dorsal valve was alone so provided, but I can assure my distinguished friend that, although in the generality of specimens the spines on the dorsal valve were the most numerous, I possess several examples which prove beyond doubt that the ventral valve was also so provided, although generally not to the extent seen on the dorsal one. In addition to the spines, the whole surface of the shell is covered with minute punctures, which are the external orifices of the tubuli or perforations which traverse the entire thickness of the valve. It will not be necessary to describe in detail the markings observable upon the interior surface of the valves, as I have done so for *O. resupinata*, but a glance at the respective illustrations will suffice to explain the differences in the species under description. These in the ventral valve are evinced in the narrowness of the median ridge and less inclined slope of the occlusor muscular impressions; while in the dorsal valve the space occupied by the occlusor, devaricator, and ventral adjustor muscles is wider than in *O. resupinata*; there is also a singular impression at the base of the fissure marked N. in the figure, and which is with some uncertainty referred to the pedicle muscle.

O. Michelini is not a rare shell in Scotland. In Lanarkshire it occurs at Langshaw Burn at three hundred and seventy-five fathoms lower than the "Ell Coal;" at Brockley and Middleholm, near Lesmahago; Auchentibber, Calderside, and Phillipshill, High Blantyre; Capel Rig, East Kilbride; and at Robroyston, north of Glasgow. In Renfrewshire, at Orchard-quarry, Thornliebank; Barrhead and Howood, near Paisley. In Ayrshire, at Roughwood, West Broadstone, and Treehorn, near Beith; Auchenskeigh, Dalry, Goldcraig, and Monkredding, near Kilwinning; Hallerhirst, Stevenston; Craigie, near Kilmarnock, and Cessnock near Galston. In Stirlingshire it is found in several stages. At Craigenglen, the Campsie main-limestone and Corrie Burn. In Dumbartonshire, at Castlecary. In Fifeshire, at Charlestown and Limekilns, above Queensferry.

* *Anomiæ striatæ* of Ure, "History of Rutherglen and East Kilbride:" 1793. Pl. xiv., figs. 13 and 14.

GENUS STROPHOMENA. Rafinesque. 1820.

This palæozoic genus appears to have been as much restricted in its vertical range as was *Orthis*, for but a single species is known to me from the Scottish Carboniferous strata, and no well authenticated example of the genus appears to have been observed in any of the subsequent periods. The shells of which this group is composed vary considerably in shape and character, being generally semi-circular, with a long straight hinge-line, the ventral valve being either convex or concave, while the dorsal one usually follows the curves of the other.

XXIV.—STROPHOMENA RHOMBOIDALIS, Wahl., *var. analoga*, Phillips. Pl. i., figs. 26-33.

Anomites rhomboidalis, Wallenberg, Acta. Soc. Ups., vol. iii., p. 65, No. 7, 1821. = *Producta depressa*, Sowerby, Min. Con., tab. 459, 1823; *Producta analoga*, Phillips' Geol. of York, vol. ii., p. 215, pl. vii., fig. 10, 1836. etc.

Of this species there are two well marked varieties, the first or typical one varies somewhat in shape, but is more often semicircular, with a very long hinge-line. The ventral valve is geniculated, or, in other words but slightly convex or flattened up to a certain distance, and up to a certain age, when the valve becomes suddenly deflected downwards at almost right angles. The margin is undulated; concave near the cardinal angles, it afterwards bulges out to form in front another slight inward or outward curve. On the flattened portion of the valve there exists a variable number of slightly undulating and irregular concentric wrinkles which turn outwardly towards the cardinal angles, and thus follow the marginal curves. The entire surface is also covered with numerous thread-like radiating striæ, and a small circular foramen is generally observable in the young, or up to a certain age, when it becomes obliterated or cicatriced in the adult. The dorsal valve usually follows the curves of the opposite one, and is similarly wrinkled and striated. The area in both is narrow and sub-marginal, with a small fissure in the ventral one, partially covered by a pseudo-deltidium. In the interior of the ventral valve two diverging teeth articulate with corresponding sockets in the opposite valve. The muscular impressions in this valve are margined by a semicircular ridge, continued from the base of the teeth, and curving on either side so as to produce a saucer-shaped depression; the occlusor leaves a scar on either side, close to a small median ridge, the devaricator filling on either side the anterior portion of the cavity; the ventral, adjustor, and pedicle muscles do not appear to have produced any very definite scars, but it is highly probable that an attachment for these muscles existed in the posterior portion of the saucer-shaped depression above described, from the fact that a small circular peduncular foramen is also sometimes observable at a short distance from the extremity of the beak, and which denotes that a pedicle muscle must have existed, although the foramen became closed as soon as the animal found it could dispense with the moorings required during the early stages of its development. In the interior of the dorsal valve the cardinal process is divided into two lobes, and not connate with the diverging socket-ridges. From the base of this a slight median ridge runs down and separates the two pairs of occlusor scars, which are bordered by prominent ridges. The vascular impressions consist of large primary vessels, which run at once direct to a short distance from the frontal margin, when they become reflected on either side to surround the ovarian spaces.

The second variety, or *Lept. distorta* of J. de C. Sowerby (Min. Con., tab. 615, fig. 3) is more properly speaking a malformation of the *Stroph. rhomboidalis*, var. *analoga*, and in which the dorsal valve becomes convex instead of concave; but all the other characters are similar to those of the typical shape,

and the name *distorta* should therefore be retained only as a varietal designation.

In 1843, Prof. de Koninck observed with justice that it was impossible to distinguish the Silurian *Stroph. rhomboidalis* from the Carboniferous *St. analoga*, and he united the two, as well as several others, under a single denomination; and although the generality of palæontologists have preferred retaining the two as distinct species, they have also admitted that it was scarcely possible to separate the Silurian, Devonian, and Carboniferous specimens. Both varieties have been found in Scotland; while the typical form has sometimes attained an inch and a-quarter in length by two and a-half in breadth, and still larger individuals have been obtained in England and in Ireland. In Stirlingshire the typical variety is found in the Campsie main-limestone and Corrie Burn beds; while the variety *distorta* occurs at Gare in Lanarkshire, at two hundred and thirty-nine fathoms below the "Ell coal," and three hundred and forty-three at Waygateshaw; in Renfrewshire, at Davieland-quarry, near Thornliebank.

Sub-genus Streptorhynchus. King. 1849.

The shells composing this sub-genus are closely related to *Strophomena*; they are usually semicircular, convex, or concavo-convex, and externally striated; the ventral valve possessing a prolonged and oftentimes bent or twisted beak. But a single species and some varieties occur in Scottish Carboniferous strata.

XXV.—Streptorhynchus crenistria. Phillips. Pl. i., figs. 16-25.

Spirifera crenistria, Phillips' Geol. of Yorkshire, vol. ii., pl. ix., fig. 6, 1836. *Spirifera arachnoidea*, *S. senilis*, and *S. radialis* of Phillips; *Orthis Kellii*, *O. cylindrica*, *O. caduca*, *O. granulosa* (?), and *O. Bechei*, M'Coy; *O. Sharpei*, Portlock; and *O. Portlockiana*, Semenow, appear to be either synonyms or simple varieties of *Str. crenistria* of Phillips.

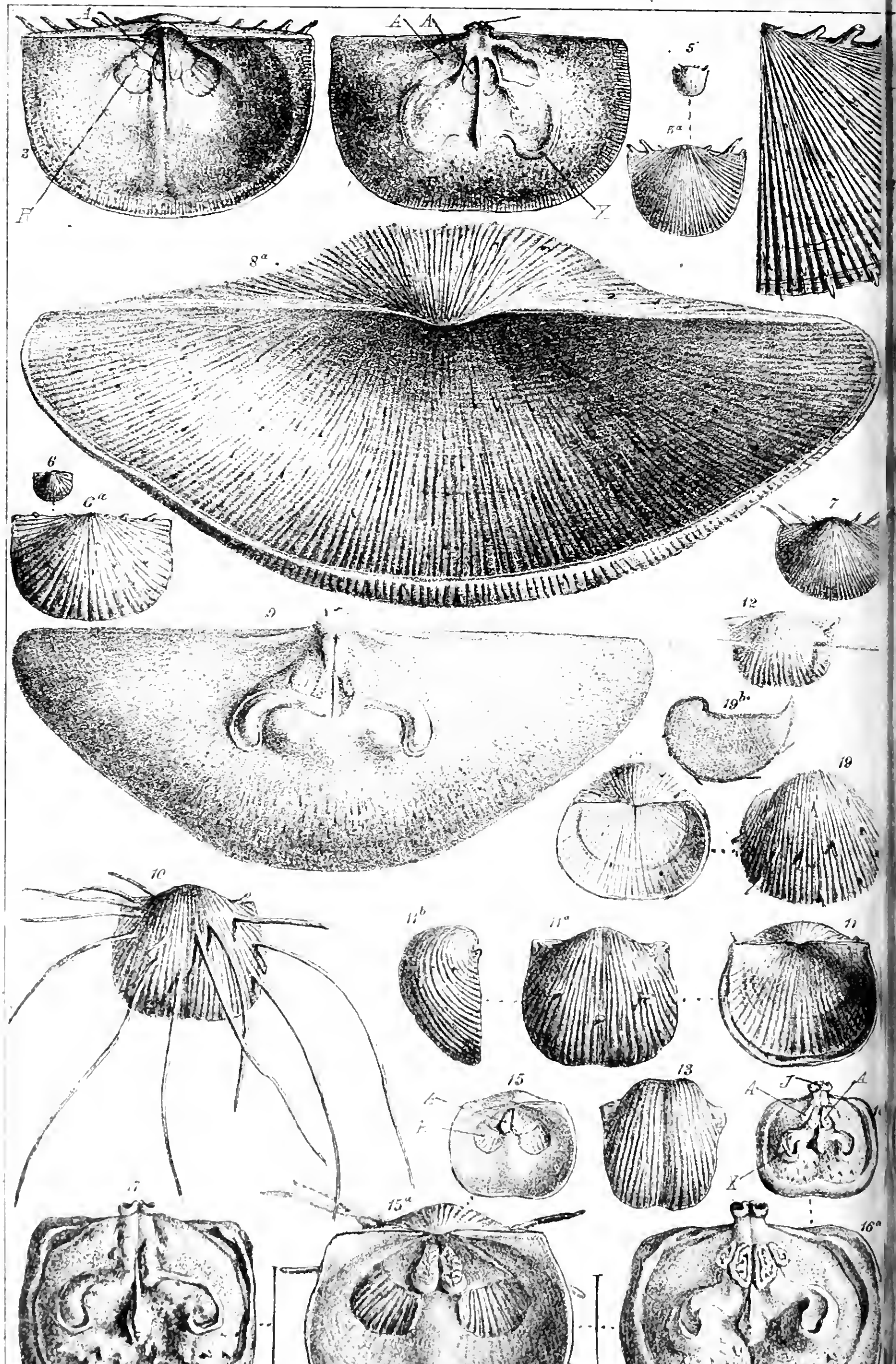
The shells of which this species is composed are more often compressed and semicircular; the hinge-line straight, and either a little shorter or slightly exceeding the width of the shell at the prolonged acute cardinal angles. The valves vary considerably in their curves and directions; in some specimens they are both convex or much compressed, and straight throughout, while in other examples the dorsal one alone is convex, or flat to a certain distance, when it becomes deflected, and assumes a lesser or greater degree of convexity; the ventral valve being in the same shell convex at, and to some distance from, the beak, when it becomes slightly concave towards the margins, following the curves of the opposite valve. The area in the dorsal valve is linear, while that of the ventral one varies much in breadth and regularity on account of the beak being sometimes twisted more to the one than to the other side. The ventral area is likewise divided by a triangular fissure, covered by a pseudo-deltidium. Exteriorly the valves are ornamented with numerous strong radiating crenulated striæ, of unequal thickness, which increase in number towards the margin, while the interspaces are similarly and partially occupied by one or more smaller longitudinal striæ. In the interior of the dorsal valve a strong hinge-tooth is situated on either side at the base of the fissure, supported by small dental or rostral plates. The muscular impressions form a saucer-shaped depression, partially surrounded by a slightly elevated ridge; the occlusor (A) occupies the central portion, and forms two small elongated impressions, separated by a slightly elevated mesial ridge, and on either side are the larger scars (R), apparently composed of two parts, the anterior or central being due to the divaricator, while the other or outer one would be produced by the ventral adjustor? In the interior of the dorsal valve, the cardinal process (to which were affixed the divaricator muscular fibres) is composed of two testaceous projections.

The socket-plates are large, and partially united to the lower portion of the cardinal process. Under these, on the bottom of the valve, may be seen the quadruple impressions left by the occlusor, and which occupy above one-third of the length of the valve, and are arranged in pairs, divided by a short rounded median ridge.

Many so-termed species appear to have been created out of this most variable species, and indeed it is most puzzling and difficult to say how far we may be permitted to limit the extent of variation, but it has appeared to me (after a minute and lengthened examination of a multitude of English, Irish, Scotch, and foreign examples of these said species) that they all appear so intimately connected and linked together by intermediate and insensible graduations of shape, that one would not be justified, I think, in maintaining as distinct what ought in reality to be united. In Scotland we find examples which might be referred to the *Strep. crenistria, St. arachnoideus, St. senilis, St. radialis,* and *St. Kellii,* and of most of which representations are given in our plate; but considering *St. crenistria* as the typical shape, if any of the other names are retained, they should be so simply as varietal designations. *St. crenistria* has sometimes attained considerable dimensions, a Scottish example having measured three inches in length by four and a-half in width, and of this an outline (fig. 17) will be found in our plate, and the British Museum possesses a Belgian example of still larger proportions. It is also a Devonian as well as a Carboniferous species.

Fig. 16 of our plate would agree with Phillips' original typical form of *St. crenistria. St. arachnoideus* is a still more depressed condition of the species, while in the variety *senilis* the convexity of the ventral valve is unusually great. In *St. Kellii* the dorsal valve is more than ordinarily convex, with a slight depression along the middle, while the ventral valve, convex at or about the beak, becomes concave towards the margin. The external sculpture varies likewise in different specimens, for it so happens that the larger radiating striæ are at times so close that there exists hardly space sufficient for a single smaller longitudinal striæ, while on the contrary, in other examples, in the intervening spaces, there is room for two or more distinct but smaller longitudinal striæ, and in this last category will be found located the *S. radialis.* If, therefore, we are to maintain as distinct the so-termed species enumerated at the commencement of this description, it will be necessary to create as many more, for it will be often most puzzling to know where to locate several of those intermediate shapes which unite *St. senilis* and *St. radialis* to *St. crenistria,* etc. The varieties *crenistria* and *radialis* were figured by David Ure in his "History of Rutherglen and Kilbride:" 1793.

St. crenistria and its varieties *radialis* and *senilis* occur in many Scottish localities. At Gare in Lanarkshire it occurs at two hundred and thirty-nine fathoms below "Ell coal," and three hundred and forty-one at Raes Gill. It is found also at Brockley and Middleholm, near Lesmahago; Auchentibber, High Blantyre; Robroyston, north of Glasgow; and at Philipshill and Darnley-quarries, East Kilbride. In Renfrewshire, at Barrhead and Orchard-quarry, Thornliebank. In Dumbartonshire, at Netherwood, near Castlecary. In Ayrshire, at Roughwood and West Broadstone, Beith; Auchenskeigh, near Dalry; Goldcraig and Monkredding, Kilwinning; Hallerhirst, Stevenston; Craigie, near Kilmarnock; Neathernewton and Moscow, parish of London; and Meadowfoot, near Drumclog; also Cessnock, near Galston. In Stirlingshire it is found in several stages. In the Balglass and Mill Burn beds, the Campsie main-limestone, and Corrie Burn beds. It occurs also in Arran and Bute. In Fifeshire the varieties above enumerated, as well as *St. Kellii* have been found at Limekilns, above Queensferry.



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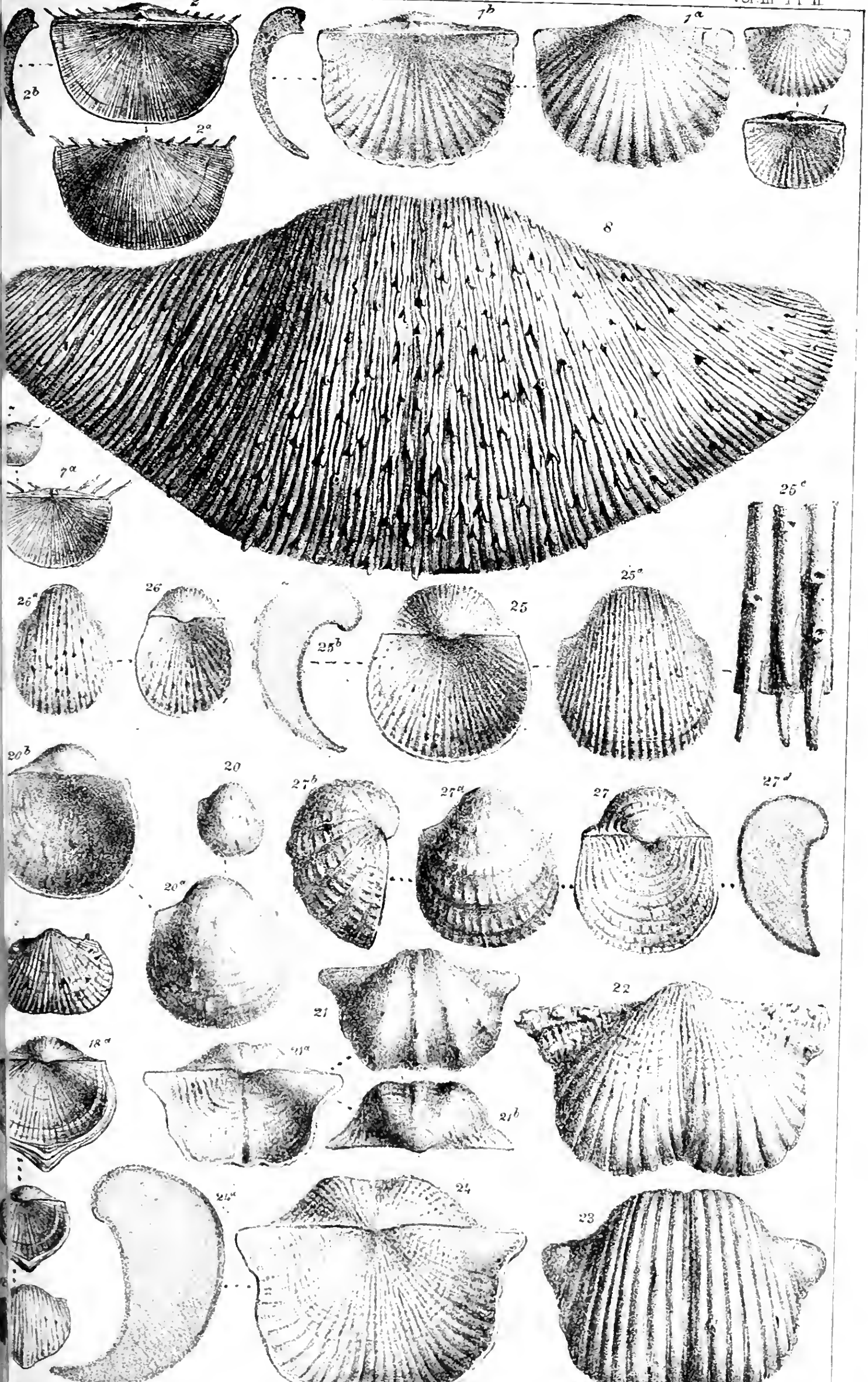
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FAMILY PRODUCTIDÆ.

In the second volume of the "GEOLOGIST" the characters of the *Productidæ* have been fully described and illustrated, we will, therefore, generally observe that this family has been divided into four genera, or sub-genera, *Productus, Aulosteges, Strophalosia,* and *Chonetes,* but that, as they all bear too natural and intimate a relation towards each other, and that the characters brought forward for separating or distinguishing the four groups above named are of somewhat questionable value or importance, I am disposed to consider that *Aulosteges, Strophalosia* and *Chonetes* cannot be regarded as more than sub-genera or modifications of *Productus.* No calcified processes exist for the support of the oral arms. In the Carboniferous rocks of Scotland *Productus* and *Chonetes* alone have been hitherto discovered.

GENUS PRODUCTUS. Sowerby. 1814.

Fifteen or sixteen species of *Productus* have been found in Scottish Carboniferous strata, and which have been chiefly distinguished by their external shape and sculpture, for of the larger number no interiors have been hitherto procured. The interior details appear to vary but little, but there exists some small marked dissimilarities in certain species, and in order to avoid unnecessary repetitions, we will at once notice their general features.

In *Productus* the internal surface of the ventral valve is concave, a narrow mesial ridge, originating, under the extremity of the beak, separates two elongated ramified or dendritic impressions which are attributed to the adductor or occlusor muscle; and almost on a level, immediately under or above, but outside of these, there exists two deep longitudinally striated subquadrate impressions, which are in all probability due to the cardinal or divaricator muscles. Impressions referable to adjustor and pedicle muscles have not been hitherto found, although Mr. Hancock is of opinion that adjustor muscles must have existed and been arranged, so as to keep the valves adjusted to each other, and thus to have acted as a substitute for the regularly articulated hinge, which is certainly absent, if not in all (?) at least in the generality of known species. The only points remaining to be noticed in connection with this valve are the deep concave sub-spiral depressions visible in the interior of some thick shelled Producti, such as *P. giganteus,* and hollows which were probably occupied by the spiral arms.

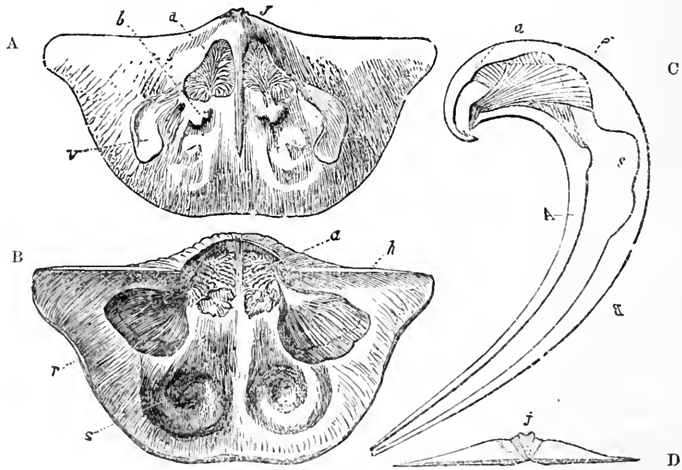
The internal surface of the dorsal valve is more or less convex, sometimes almost flat, and presents in the middle of the hinge-line a prominent bilobed, or trilobed projection or cardinal process, whose upper surface having afforded attachment to the cardinal, or divaricator muscle. Under this a narrow longitudinal ridge, or septum, generally extends to about half (or more) of the length of the valve, and on either side are seen the ramified, or dendritic impressions which we consider to be attributable to the adductor, or posterior and anterior occlusor muscles; these are at times situated so close together on either side of the median ridge, as to render the quadruple attachment not so distinct as could be desired, but they are well defined in some valves of *Productus longispinus,* as may be seen by a reference to fig. 16 of our plate 11. Outside, and in front of the muscular scars above described are the two "reniform impressions." Their surface is generally smooth; they are bounded with ridges, and after dividing the occlusor muscles, proceeded in an oblique and almost horizontal direction, then turning abruptly backwards, terminate at a short distance from their origin. There exists also in many species, but not in all, two prominences, one on each side of the median ridge, and close to the base of the muscular scars. The internal surface of Productus is covered with innumerable granulations and spinose asperities. The shell itself being likewise

minutely perforated.* Exteriorly the surface is variously sculptured, and sparingly or closely covered with hollow tubular spines. It was also during the deposition of the Carboniferous deposits that the greatest number of species and individuals prevailed, for as many as fifty species are said to occur; but it is not always easy to distinguish certain forms which may after all be but varieties of some of the better determined or characterised species. It is very desirable to see the complication of species disappear; and when a single well defined species is made to absorb one or half a dozen old and unrecognizable ones, it is a favour to science; and our constant efforts should tend to remove useless names from the nomenclature, and seek the points of similarity with even more assiduity than the differences which we are prone to exaggerate in the constant desire to create new species.

XXVI.—Productus giganteus.† Martin sp. Pl. v., figs. 1-4.

Anomites giganteus. Martin, Petrif. Derb., pl. xv., fig. 1, 1809.

This shell varies somewhat in shape according to age and specimen, but is usually more or less transversely oval, and dilated at the sides. The hinge-line is straight, and generally exceeds in width the other portions of the shell. It usually possesses no hinge-area, but in some exceptional specimens there exists a rudimentary one, especially in the ventral valve; no teeth or sockets ever existed for the regular articulating of the valves. The ventral valve is very



Ligu. 8.—*Productus giganteus.*‡

A, Interior of the Dorsal Valve. *B*, Interior of the Ventral Valve, with the umbo removed. *C*, Ideal section of both valves. *D*, Hinge-line of *A*; *j*, cardinal process; *a*, adducta, or occlusor; *r*, divaricator muscles; *b*, oral processes (?); *s*, hollows occupied by the spiral arms; *v*, vascular impressions; *h*, hinge area.

‡ These figures are by Mr. S. P. Woodward; more detailed representations will be found in our plate.

* For synonyms and more ample details on all that pertains to the species of Productus consult Prof. de Koninck's excellent "Monographie des Genres Productus et Chonetes." Liège, 1847.

† Mentioned by Ure in his "History of Rutherglen and East Kilbride:" 1793. Page 316, in his Anomiæ Echinatæ.

convex or gibbous, the cardinal angles being generally prolonged or extended in the shape of auriculate expansions, semi-cylindrically enrolled, and gradually, or more or less abruptly separated from the gibbous portion, or body, of the shell; the beak is large, rounded, and often greatly incurved, but not always overhanging the hinge-line. This valve is also either evenly convex or irregularly, and more or less deeply furrowed, the surface being likewise covered with a vast number of longitudinal flexuous striæ, which vary somewhat in thickness according to age and specimen, three or four generally occupying the width of a line towards the middle or margin of the shell; these little ribs are also frequently confluent, bifurcating, or suddenly disappearing, increasing in number as they approach the marginal portions of the shell, and at short intervals giving birth to short spines, or spinulose asperities, which were more numerous and larger upon the auriculate portions of the valve. The dorsal valve is concave, generally following the curves of the opposite valve, somewhat concentrically wrinkled near the hinge-line, and longitudinaly striated in a very similar manner to what we have described for the ventral one. It will not be necessary to describe the interior with any detail, since the general description already given, as well as the figures of our plate, will sufficiently illustrate all the characters; but we may notice the great thickness of the ventral valve compared with that of the dorsal one, which is usually thin. The ventral valves of all species of *Productus* do not possess that extraordinary thickness which admit of those deep subspiral hollows for the accommodation of the spiral arms, which are visible in the present forms. The divaricator muscular scars are here immediately under and outside of the occlusor ones, while in *Productus longispinus* and some other species, the devaricator impressions are almost upon a level with the occlusor ones. In the dorsal valve the cardinal process (which varies much in shape, according to the specimens and age of the individual) is usually trilobed, its V-shaped upper surface is usually striated, the other impressions are clearly defined in the figure.

This is certainly the largest species of the genus at present known, some English examples having attained six inches and two lines in length by eleven inches four lines in width; and although no Scottish examples have, to my knowledge, attained similar proportions, some have measured five and a-half inches in length by nine or ten in width.

Productus giganteus characterises some of the lower stages of the Carboniferous system wherein Brachiopoda have been found; thus at Braidwood Gill, in Lanarkshire, it is found for the first time at three hundred and ninety-seven fathoms below the horizon of the "Ell Coal."

In Stirlingshire it occurs in the Mill-Burn beds, Campsie. It was likewise collected in the island of Arran, by Prof. Ramsay, and in red limestone at Closeburn, in Dumfriesshire, by the late Dr. Fleming. In Edinburgshire, at Joppa. In Haddington, at Cat Craig, near Dunbar. In Peebleshire, at Carlops, etc.

XXVII.—Productus latissimus. J. Sowerby. Pl. ii., figs. 8-9, and pl. iv., fig. 26.

Productus latissimus. J. Sowerby, Min. Con., vol. iv., p. 32, pl. 330, 1822.

The shells composing this species are very transversely elliptical or spindle shaped, with a long straight hinge-line, and are completely deprived of area, the breadth being more than twice as great as the length; the ventral valve is also very convex forming in profile more than a semicircle; the beak large and much incurved, while the passage from the gibbous body of the valve into the auriculate expansions or ears is so gradual as to be more often insensible, and does not appear in the many examples that have passed under my inspection to have ever been so sharply separated, or defined, as is usually the case with *P. giganteus*; it is also much more transverse, or elliptical, than is the last named

shell, the dorsal valve being likewise extremely concave, and follows the curves of the opposite one. The surface in both valves is coarsely striated, the flexuous striæ increasing irregularly by numerous intercalations, and giving rise at short intervals to many small stout spinulose projections. The striæ are also proportionably coarser and more spinulous than in the last described species, and the shell itself much thinner. In the interior of the ventral valve the muscular impressions appear to be located nearer the extremity of the beak than in *P. giganteus*, and in the dorsal valve there appears to exist a difference in the detail of the occlusor muscular impressions, as may be seen by comparing the figures we have given of the interior of both species. *Productus latissimus* does not appear to have ever attained anything like the proportions of *P. giganteus*, for the largest example I have seen did not much exceed some two inches in length by four and a-half in width.

Sowerby, Phillips, de Koninck, de Verneuil, and the generality of authors have considered the two shells, though closely allied, to be separate species, and I am disposed to coincide with their view, although some few palæontologists, and in particular Prof. M'Coy states "positively that the distinctions do not really exist;" and it may be here mentioned that, although the two species are occasionally found in the same strata and localities, more often the one form is common, where the other is absent.

In Scotland *P. latissimus* is also one of the most characteristic species in some of the lower stages of the Carboniferous system. It is found in Lanarkshire at two different levels, thus, at Belston Burn it occurs at two hundred and sixty-five fathoms below "Ell Coal," and three hundred and ninety-one at Braidwood Gill, also at Brockley, near Lesmahago. In Renfrewshire at Arden-quarry, Thorliebank. In Ayrshire, at Roughwood and West Broadstone, Beith; Auchenskeigh, Dalry; Goldcraig and Monkredding, near Kilwinning; Hallerhirst, Stevenston; Nethernewton and Moscow, parish of Loudon; Meadowfoot, near Drunclog and Mullockhill, near Dalry. In Stirlingshire it is known to Mr. Young but from the Craigenglen (Campsie) beds. In Buteshire, in the island of Arran.

XXVIII.—Productus semireticulatus. Martin. Pl. iv., figs. 1-12.

Var. A., *Anomites semireticulatus*, Martin, Petrif. Derb., p. 7, pl. xxxii., figs. 1-2, and pl. xxxiii., fig. 4, 1809, = *P. antiquatus*, Sow., Min. Con., vol. iv., pl. cccxvii., figs. 2, 3, 4, = *P. Scoticus*, Sow., Min. Con., pl. lxix., fig. 3, = *P. sulcatus*, Sow., Min. Con., tab. cccxix., fig. 2, etc.

Var. B., or *Martini*, Sow., Min. Con., tab. cccxvii., figs. 2, 3, 4., 1821, = *Anomites productus*, Martin, Petrif. Derb., tab. xxii., figs. 1, 2, 3, 1809, = *P. concinnus*, Sow., Min. Con., tab. cccxviii., fig. 1.

This species has varied much in its general shape, and I entirely coincide with Prof. de Koninck, while considering *P. semireticulatus, antiquatus, Martini, concinnus, sulcatus*, and I will add *Scoticus*, as simple variations in shape of a single type or species, for which the term *semireticulatus* has been adopted. These varieties are all so intimately connected by insensible gradation, that it would often be impossible to say to which in particular certain specimens should be referred. Some palæontologists, who do not retain as distinct species all the names above recorded,* would however preserve several of them as varietal denominations; but after the careful examination of a multitude of specimens, I am disposed to retain but two, and which for convenience will be here briefly noticed under separate heads.

* There are other synonyms, but which cannot be here recorded. In my Monograph of British Carboniferous Brachiopoda full details will be found.

Var. A, *Productus semireticulatus*, figs. 1-8, is transversely oval, or of a rounded quadrate shape, but it is also at times somewhat elongated, the hinge-line being either rather shorter or as long as the greatest width of the shell. The ventral valve is always gibbous, with and sometimes without a shallow longitudinal median sinus, or depression, the auriculate cardinal expansions being moderately developed but clearly defined; the beak is wide and incurved, both usually covered with irregular concentric wrinkles, always larger and deeper upon the auriculate expansions, and the entire surface of the shell is covered with numerous radiating longitudinal rounded striæ, from which project at variable intervals tabular spines of moderate length. The width of the striæ, as well as the interspaces between them, varies also according to the specimen, two or more usually occupying the breadth of a line. The larger number are simple, but others bifurcate here and there, and sometimes two or more (in rare cases) will unite towards the margin, so as to form but a single rib, while others are due to intercalation. Several ribs will also at times cluster together, so as to produce an elevation, and thus giving the frontal portion of the shell a somewhat grooved appearance. The spines are likewise more numerous, larger and longer in certain examples than in others, but always most so upon the auriculate portions of the valves. The dorsal valve is slightly concave, or flattened to some distance from the hinge, so that a considerable space was left free for the soft portions of the animal; the external sculpture is also very similar to that which has been described for the opposite valve. The ventral valve is thicker than the dorsal one; both become extremely thin and sometimes recurved near their margin. The interior of both valves have been often procured, and in excellent preservation, as may be seen from the figures of our plate, and we will merely notice that in the ventral valve the occlusor impressions are situated almost upon a level with the divaricator scars, and much lower in the valve than for example in *P. giganteus*, etc. In the dorsal valve the occlusor impressions are often beautifully sculptured, and the cardinal process is trilobed.

Productus semireticulatus has sometimes attained large dimensions, a Scottish specimen represented in our plate has measured two inches three lines in length by two and a-half inches in width, and it has elsewhere assumed still larger proportions. *P. sulcatus* appears to be nothing more than a smaller variety of the same, wherein the median sulcus of the ventral valve is more than usually deepened, and upon the lateral portions of the beak (close to the auriculate expansions) there existed sometimes, but not always, a somewhat elevated ridge, with a row of rather large prominent spines. *P. Scoticus* appears to me to be undoubtedly a variation of shape only of the species under description, and not of *P. giganteus*, as has been supposed by some palæontologists. I have had the loan of the original figured specimens for several months in my possession, and both valves will be found represented in our plate.

Var. B, or *Martini*, figs. 10-12, is distinguished from the preceding one by the great length and irregularity of its anterior prolongation; the arched beak is suddenly bent downwards in an almost straight line, giving to some specimens a peculiarly elongated and geniculated appearance. The dorsal valve is slightly flattened to some distance from the hinge-line, when it closely follows the curves of the opposite one. The thinness of the shell sometimes makes it liable to fracture at some distance from the beak, as may be seen in one of the figures; the lateral portions of the valve are likewise much dilated, with numerous spines sometimes projecting from the auriculate portions of the valve. The beak is concentrically wrinkled, and the entire surface is covered with thread-like striæ, which bifurcate sometimes several times, especially upon the lateral portions of the shell.

This is the variety to which Martin in 1809 applied the specific denomination of *Anomites productus*, and of which Sowerby's *P. concinnus* is evidently only a

smaller variety or synonym; *P. semireticulatus*, and its variety *Martini* is one of the commonest species of the genus we find in Scotland.

In Lanarkshire it has been collected in several stages; thus, in the parish of Carluke, at Braidwood-meadow, it is found at three hundred and seventeen fathoms below the "Ell coal," three hundred and forty-three at Langshaw Burn, three hundred and seventy-five at Mosside and Nellfield, three hundred and ninety-one at Braidwood Gill. It occurs also at Brockley, Birkwood, and Middleholm, near Lesmahago; Calderside, East Kilbride; on the east bank of the Avon, near Strathavon; and Robroyston, north of Glasgow. In Renfrewshire, at Arden- and Orchard-quarries, Thornliebank; Barrhead and Howood, near Paisley. In Ayrshire, at Roughwood and West Broadstone, Beith; Auchenskeigh, Dalry; Goldcraig and Monkredding, near Kilwinning; Cessnock, parish of Galston; Nethernewton, parish of Loudon; Craigie, near Kilmarnock. In Dumbartonshire, at Netherwood and Castlecary. In Stirlingshire it occurs in several stages, such as Craigenglen, Balglass Burn, Mill Burn, Balgrochan, Campsie main-limestone and ironstone, black limestone and shale of South Hill (Campsie), Balquarhage and Corrie Burn. It has also been collected in Bute, in Fifeshire, and in the Lothians.

XXIX.—Productus longispinus. Sowerby. Pl. 2, figs. 10-19.

Productus longispinus, Sowerby, Min. Con., vol. i., p. 154, pl. lxviii., fig. 1, 1814, = *P. Flemingii*, Sow., = *P. spinosus*, Sow., = *P. lobatus*, Sow., etc.

The shell we are about to describe somewhat resembles *P. semireticulatus*, but is always a much smaller species, and well distinguished by some of its interior details. It is usually slightly transverse, but sometimes, though more rarely, a little longer than wide, the hinge-line being about as long as the greatest width of the shell. The ventral valve is convex, and at times gibbous, with or without a mesial sinus, which, commencing at a short distance from the extremity of the rounded and incurved beak, becomes wider and deeper as it approaches the frontal margin; the auriculate cardinal expansions are small and slightly wrinkled, while the entire surface of the valve is covered with numerous small radiating rounded striæ, tolerably regular in their course and respective width, but augmenting in number here and there by the means of occasional bifurcation and intercalation. A few irregularly scattered and very long slender tabular spines project from some of the ribs, and are more numerous on or near the auriculate expansions. The dorsal valve is concave, with a small mesial rounded elevation towards the frontal margin; its surface is striated, as we have already described for the ventral one, both valves being likewise marked with small concentric undulating wrinkles on the beak, and to some distance from the hinge-line. Beautifully perfect interiors of both valves are not very rare in certain localities. On the concave surface of the ventral one, two elongated contiguous dendritic occlusor impressions project at times considerably above the level of the valve, and immediately under but outside of these may be seen the two large longitudinally striated subquadrate impressions attributable to the divaricator muscle. A glance at our figures of this and at the corresponding valve of *P. semireticulatus* will explain better than could be done with words the difference in position occupied by these muscles in the two species. The occlusors in the last-named shell are almost upon a level and longitudinally parallel with the divaricators; while in *P. longispinus* the divaricators commence only at or close to the base of the occlusors. A difference in the arrangement of these muscles occurs likewise in *P. punctatus*, and denotes that the three species might be distinguished alone by the details connected with these interior arrangements, and hence the importance of seeking for the interiors of those species of which we do not possess—the detached valves, or

their internal casts, which are often quite as instructive. In the interior of the dorsal valve the cardinal process is proportionally large and trilobed, under which a median longitudinal ridge extends to a little more than half the length of the valve, and becomes much elevated and thickened towards its extremity; on either side may be seen a pair of dendritic scars formed by the occlusor muscle; the reniform impressions are also well defined, and often much raised, and the surface of the valve is covered near its margin with numerous spinulose asperities; minute canals traversing the valves are also clearly visible in the shape of punctures, especially upon specimens that have been slightly weathered.

P. longispinus is a common Scottish species, but which rarely attains or exceeds nine or ten lines in length by ten or eleven in width, and it is quite certain that several so termed species have been made out of accidental differences peculiar to certain specimens. I have adopted the term *longispinus*, as it stands first among the synonyms, and because I believe the species is best known by that denomination among British palæontologists. *P. Flemingii* was badly drawn and described from a very imperfect specimen; while *P. lobatus* is only a variety in which the median sulcus or furrow in the ventral valve is deeper than usual, and is to *P. longispinus* what *P. sulcatus* is to *P. semireticulatus*, =, *P. spinosus* appears also to have been drawn from a specimen of the shell under description, but wherein the median sinus has not been developed. The original figured specimens of all these so termed species were kindly lent to me by Prof. Fleming, and of which figures will be found in our plate. Some other synonyms will be recorded and explained in my larger work, but which cannot be alluded to in the present memoir.

P. longispinus occurs in several stages. At Braidwood, in Lanarkshire, it occurs at three hundred and thirty-seven fathoms lower than the "Ell coal;" three hundred and thirty-eight at Hallcraig; three hundred and forty-one at Raes-Gill; three hundred and forty-three at Langshaw; three hundred and fifty-four at Hill Head; three hundred and seventy-one at Kilcadzow; and three hundred and seventy-five at Thornmuir and Mosside, all in the parish of Carluke. It is found also at Kersegill and Brockley, near Lesmahago; Auchentibber and Calderside, High Blantyre; Capel Rig, East Kilbride; the east bank of the Avon, near Strathavon. In Renfrewshire, at Arden- and Orchard-quarries, Thornliebank. In Dumbartonshire, at Castlecary. In Ayrshire, at Roughwood and West Broadstone, Beith; Auchenskeigh, Dalry; Goldcraig, near Kilwinning; Craigie, near Kilmarnock; and Nethernewton, parish of Loudon. In Stirlingshire it occurs in several stages at Craigenglen, Balglass Burn, Balgrochan, the Campsie main-limestone, and Corrie Burn. In Buteshire in the island of Arran. In Midlothian, at Dryden, etc. In Haddingtonshire, at East Barns, near Dumbar, etc., and is found also in Fifeshire.

XXX.—Productus carbonarius. De Koninck. Pl. iv., fig. 14.

Productus carbonarius, de Koninck, Description des Animaux Fossiles du Terrain Carbonifere de la Belgique, p. 181, pl. xii. *bis*, fig. 1, 1843, and Monographie du Genera Productus, pl. x., fig. 4.

Of this species I am acquainted with but a single Scottish example. It measures ten lines in length by eleven in width. The ventral valve is somewhat transversely oval, gibbous and evenly rounded, with small auriculate expansions, and a hinge-line as long as the greatest width of the shell. The external surface is ornamented with numerous fine thread-like radiating striæ, tolerably regular in their course, and bifurcating but rarely upon their anterior prolongation. From each rib projects, at short intervals, numerous slender spines, the rib itself becoming thickened at the spot from

where the spine originates. The beak is small, incurved, and covered with a few slight concentric wrinkles. In the specimen under description the dorsal valve could not be seen, nor am I acquainted with its interior arrangement.

The specimen here described is stated to have been derived from the north of Glasgow, and is preserved in the Museum of Practical Geology, in London.

XXXI.—Productus cora. D'Orbigny. Pl. iv., fig. 13.

Productus cora, A. d'Orbigny, Paléontologie du Voyage dans l'Amerique Meridionale, p. 55, pl. v., figs. 8, 9, 10, 1842, and de Koninck, Mon. du Genre Productus, pl. iv., fig. 4, and pl. v., fig. 2, = *Producta corrugata*, M'Coy.

The shells composing this species are usually longer than wide, and sometimes irregular in their anterior prolongation; the ventral valve is very convex, regularly vaulted, and at times slightly flattened along its middle; the auriculate expansions are small, but crossed by several deep undulating folds, which extend to some distance over the lateral portion of the valve, the beak being small and much incurved, while the hinge-line is about as long as the greatest width of the shell. The dorsal valve is concave, following closely the curves of the opposite one; both are covered with numerous longitudinal slender flexuous filiform striæ, while occasional smaller ones are implanted between the older, at variable distances from the beak, and which become gradually wider and wider, until they acquire the width of those on either side.

Hardly any spines seem to have adorned this shell, a few only being sometimes observable upon the auriculate expansions, and near to the hinge-line. The interior has still to be discovered, and although the species has attained largish dimensions in various carboniferous districts, no Scottish example I have hitherto seen did much exceed an inch in length by something less in width.

P. cora does not appear to have been discovered in many Scottish localities. In Stirlingshire it occurs in three different but consecutive stages, viz., the Mill Burn and Balgrochan beds, and in the Campsie main-limestone, and ironstone. In Renfrewshire it may be collected at Arden quarry, near Thornliebank; and in Ayrshire, at West Broadstone, near Beith.

XXXII.—Productus undatus. Defrance. Pl. iv., fig. 15-17.

Productus undatus, Defr. Dict. des Sc. Nat., vol. xliii., p. 354, 1826, and De Koninck Monographie du Genre Productus, pl. v., fig. 3.

In Scotland this shell does not appear to have quite attained an inch in diameter, is suborbicular and slightly transverse, the hinge-line being rather shorter than the greatest width of the shell. The ventral valve is very convex, with small auriculate expansions, while the dorsal valve is moderately concave; both are covered with numerous irregular, deep, concentric folds, or undulating wrinkles; and in addition the entire surface is longitudinally striated in a very similar manner to what we have described in the preceeding species. The transverse folds are very remarkable and easily distinguish the present species from any of the others; they vary much, however, in their width, depth, and number: thus, upon some shells, sixteen or seventeen may be counted upon either valve, while in others they do not number much more than half as many, and would appear to have been wider and deeper in some smaller shells than in the larger ones. But few spines appear to have projected from the ribs. The interior of the valves have still to be discovered.

P. undatus does not appear to have been very abundant in Scotland. At Gare, in Lanarkshire, it occurs at two hundred and thirty-nine fathoms below the "Ell coal," and three hundred and forty-three at Headsmuir. In Stirling-

shire it occurs in the Mill Burn beds, and in the Campsie main-limestone. In Dumbartonshire, in the Castlecary limestone.

XXXIII.—Productus scabriculus. Martin. Pl. iv., fig. 18.

Anomites scabriculus, Martin, Petrif. Derb., pl. xxxvi., fig. 5, 1809. *Productus*, Sowerby, Min. Con., vol. i., pl. clvii., pl. lxix., fig. 1.

This shell is marginally rotundate-quadrate, and somewhat wider than long, the ventral valve being convex, with small flattened auriculate expansions, and a wide, but slightly deepened mesial depression, or sinus; the hinge-line is either shorter, or as long as the width of the shell, while the dorsal valve becomes slightly concave, with a small median elevation, or fold, apparent only in the vicinity of the frontal margin. The surface of the larger valve is closely covered with numerous subregular striæ swelling out at close intervals in the shape of oblong tubercles, arranged somewhat irregularly in quincunx, and from which project short curved spines; the valves are likewise at times feebly concentrically wrinkled, and the surface of the dorsal valve is marked with numerous small elongate, oval, tubercle-pits.

I am not acquainted with any good interiors of this species; all I know of the dorsal valve is derived from an internal cast in ironstone, from Jock's Burn, in the parish of Carluke, and which shows that the cardinal process was bilobed, and that a small median ridge extended from its base to a little more than half the length of the sheil, the muscular and reniform impressions were very faintly marked, but appear to be similar to those of *Productus punctatus*. The largest Scottish examples with which I am acquainted measured fifteen lines in length by sixteen in width, but the shell has attained much larger dimensions in the neigbourhood of Dalry.

P. scabriculus is plentiful in ironstone, at Jock's Burn, in Lanarkshire, at three hundred fathoms below the "Ell coal," three hundred and seventy-five at Braidwood and Hill Head, in the parish of Carluke, at Brockley, near Lesmahago, and Robroyston and Moodies Burn north of Glasgow. In Stirlingshire it occurs in several stages, such as the Craigenglen beds, Campsie main-limestone and ironstone, and Corrie Burn. In Renfrewshire, at Barrhead; Howood, near Paisley; and Arden-quarry, Thornliebank. In Dumbartonshire at Castlecary. In Ayrshire, at Auchenskeigh, Dalry; and West Broadstone, Beith. It has also been found in Fifeshire and in the Lothians.

XXXIV.—Productus punctatus. Martin. Pl. iv., fig. 20-22.

Anomites punctatus, Martin, Petrif. Derb., p. 8, pl. xxxvii., fig. 6., 1809. *Productus*, De Koninck, Monographie du Genre Productus, pl. xii., fig. 2 = *P. elegans*, M'Coy, etc.

The shells of which this species is composed vary somewhat in shape from being transverse, or slightly elongated; all are, however, more or less rotundate-quadrate, with a hinge-line shorter than the greatest width of the shell, the auriculate expansions being flattened, but not always clearly defined. The ventral valve is moderately convex, with a wide longitudinal sinus, commencing at a short distance from the extremity of the beak, this last being small and incurved. The dorsal valve is but moderately concave, with a very slight mesial elevation, which commences at about the middle of the valve and extends to the front. The surface of the valves are externally covered with numerous sub-regular concentric bands, or ridges of growth, which increase in number and breadth as they recede from the extremity of the beak and hinge-line, but in very adult shells they again become closer and closer as they approach the margin. These bands (in the ventral valve) are slightly raised towards their lower margin, and are abruptly separated from each other by a narrow

smooth space, after which there exists a tolerably regular row of lengthened tubercles, or slender shining tubular spines, and again, below these, the remaining space is filled up by irregularly scattered, but closely packed smaller spines; all, however, overlap each other, and lie so close to the valve that none of the surface of the living shell could be perceived. In the dorsal valve the bands are slightly concave, but the same arrangement of the spines is observable.* The shell in this species appears to have been thin, so that it cannot be easily detached perfect from hard limestone matrix, but from certain shales weathered specimens can be collected with all their spiny investment completely preserved. The interior of both valves have been found. In the dorsal one, the cardinal process is very peculiar in shape, and bilobed, but the muscular and reniform impressions do not differ materially from those of other species of the genus. In the ventral valve, however, the occlusor impressions extended much lower in the valve than those attributable to the divaricator muscle, and thus differ from what we observe to have been the case in *P. giganteus*, *P. semireticulatus*, and other species.

The shell under description attains sometimes larger proportions than have done any of the Scottish examples that have come under my direct observation. A specimen from Ayrshire has measured two inches and a-half in length by nearly two inches in width.

Productus punctatus is not a rare Scottish fossil. It occurs at Langshaw Burn, in Lanarkshire, at three hundred and forty-three fathoms below the "Ell coal," three hundred and seventy-five at Nellfield, and four hundred and ten at Nellfield Burn; also at Brockley, near Lesmahago. In Renfrewshire, at Howood, near Paisley; Barrhead- and Arden-quarry, Thornliebank. In Dumbartonshire, at Castlecary. In Ayrshire, at Roughwood and West Broadstone, Beith; Auchenskeigh, Dalry; Goldcraig, Kilwinning; Cessnock and Nethernewton, parish of Galston. In Stirlingshire, at Craigenglen, Mill Burn, the Campsie main-limestone and ironstone, and Corrie Burn. It has also been found in the island of Arran and in Bute, as well as in the Lothians and Fife.

XXXV.—Productus fimbriatus. J. de C. Sowerby. Pl. ii., fig. 27.

Producta fimbriata, J. de C. Sowerby, Min. Con., vol. v., p. 85, pl. ccccl ix., fig. 1, 1823. *Productus fimbriatus*, De Koninck, Monographie du Genre Productus, pl. xii., fig. 3.

This is a much smaller species than the preceding one, rarely exceeding an inch and a-quarter in length by something less in breadth: its shape is longitudinally oval, or ovate, the hinge-line being a little shorter than the greatest width of the shell. The ventral valve is very gibbous and greatly arched in profile, with its beak much incurved, and regularly vaulted, the extremity being attenuated, and overlying the hinge-line of the opposite valve; the ears are small and but slightly marked. The dorsal valve is either nearly flat, or but very slightly concave. As in *P. punctatus*, the surface of the valves are externally covered with numerous sub-regular, concentric, prominent, bands, which are in general more separate than in the preceding species. No example I have hitherto seen possessed its outer shell and spiny investment in any thing like a perfect condition, but a fragment tolerably well preserved has led me to conclude that the arrangement of the tubular spines did not materially differ from that of *Productus punctatus* for there evidently did exist some smaller spines under the row of larger ones, but which alone seem to have left

* In 1793, David Ure gave us a very good description of this shell; he states that both valves are covered with small spines resembling hair, and so numerous that a largish example contains upwards of ten thousand; and that they lie so closely together that the surface of the shell is entirely concealed from view.

elongated tubercles on the surface of the casts. The larger spines do not, however, appear to have been quite so close together as in the preceding species. Therefore, although *P. fimbriatus* possesses much similarity in character to *P. punctatus*; it may be easily distinguished by the elongated oval shape of its valves. *P. fimbriatus* is found at Hill Head, in Lanarkshire, at three hundred and seventy-one fathoms below the "Ell coal;" also at Middleholm, near Lesmahago. In Stirlingshire, in the Campsie main-limestone. In Ayrshire, at West Broadstone, Beith; Meadowfoot, near Drunclog; Cessnock, parish of Galston. It has also been found in the Lothians and in Fifeshire.

(To be continued.)

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London, *January* 4, 1860.—Prof. J. Phillips, President, in the Chair.

"On the Flora of the Silurian, Devonian, and Lower Carboniferous Formations." By Prof. H. R. Goeppert, For. Mem. G.S.

The number of all the fossil plants which the author has described as belonging to these formations (chiefly from Germany) amounts to one hundred and eighty-four species: Algæ, thirty species; Calamineæ, twenty; Asterophylliteæ, 4; Filices, sixty-four; Selagineæ, thirty-nine; Cladoxyleæ, four; Noeggerathiæ, eight; Sigillariæ, six; Coniferæ, six; Fruits (uncertain), three. Prof. Goeppert has seen only Algæ from the Silurian Rocks. *Sigillaria Hausmanni* is one of the most interesting of the Lower Devonian plants mentioned; and *Sagenaria Weltheimiana*, of the Middle Devonian. The Upper Devonian has several terrestrial plants. Of the Lower Carboniferous Flora, the following are the most important and characteristic plants:—*Calamites transitionis*, *C. Roemeri*, and *Sagenaria Weltheimiana*. The last name supersedes *Knorria imbricata*.

"On the Freshwater Deposits of Bessarabia, Moldavia, Wallachia, and Bulgaria." By Capt. T. Spratt, R.N., C.B., F.R.S., F.G.S.

Capt. Spratt first referred to the many isolated patches of freshwater deposits in the Grecian Archipelago and in the neighbouring countries, also around the Black Sea, to which others have alluded or which have been described by himself as evidences of the existence of a great freshwater lake, probably of middle tertiary age.

On the borders of the Yalpuk Lake, in Southern Bessarabia, are sections exhibiting old lacustrine deposits containing similar fossils to those found elsewhere by Capt. Spratt in the strata referred by him to the extensive oriental lake of the middle tertiary period. Among these fossils are freshwater cockles; such as are associated with *Dreissina polymorpha* in the strata at the Dardanelles and elsewhere. After some search Capt. Spratt found similar cockles living in the Yalpuk lake; and from this evidence, and from the relatively different levels of the old lacustrine deposits and the present Black Sea, he satisfied himself of the really freshwater condition of the old tertiary lake; the Black Sea area having been separated from the old lacustrine area of Bessara-

bia and the Provinces by a barrier at the Isaktcha hills which the Danube has since cut through. Capt. Spratt remarked that the lacustrine conditions of the great area in Eastern Europe and Asia Minor where he has indicated freshwater deposits were probably interfered with by volcanic outbursts, which opened a communication between the Euxine and Mediterranean, altering the levels of the region, causing the formation of the great gravel-beds at the foot of the Carpathians, and an outspreading of the brown marly superficial deposits of the Steppe, which are locally impregnated with mineral or marine salts, indicative either of the influx of the sea, or of mineral solutions set free by volcanic agencies.

Capt. Spratt also described the older rocks, some probably of Triassic age, and others Cretaceous, which are here conformably overlaid by the lacustrine deposits. These he saw in the hills, south of the Danube, near Tultcha and Beshtepeh; also at the Raselm Lagoon, where both Cretaceous shales and marble containing *Ceratites*, &c., occur; the latter at Popin Island. At Dolashina, a cape south of the Raselm Lagoon, the soft Cretaceous limestone is full of small *Inocerami*.

These indications of Secondary rocks are intimately connected with those further south, at Cape Media and Kanara, formerly described by the author.

Liverpool Geological Society.—*January* 10, 1860.

"On the Basement-bed of the Keuper Formation in Wirral, and the South-west of Lancashire."

After referring to the subdivisions of the Trias, he described the character of the upper red and variegated sandstone of the Bunter formation, showing that it had suffered a considerable amount of denudation previous to the deposition of the Keuper. A bed of upper Bunter sandstone in Wirral is found to be almost entirely denuded on the northern side of the Mersey, only the faintest traces of it being visible. A slight unconformity seems very probable, but the surface of the Bunter is so eroded and uneven, that it is very difficult to arrive at an exact and satisfactory conclusion upon that important point.

The base of the Keuper is very uniform in its lithological aspect throughout the district, being a conglomerate or coarse sandstone containing quartz-pebbles and nodules of clay. In colour the bed varies, but it can always be distinguished by its hardness from the Bunter sandstone beneath. For these and other minor reasons, the author of the paper stated that the Bunter had been exposed to denudation for a long period prior to the deposition of the Keuper, and that most probably the surface of the former was dry land during the time that the Muschelkalk was being formed in more southern and easterly regions. With the exception of the well known footprints of Emydians and Batrachians, not a trace of any animal or plant had been found in either the Bunter or Keuper formations of the neighbourhood.

The examination of the three railway-tunnels under the town of Liverpool, and of other artificial openings, satisfactorily proves that the basement-bed of the Keuper on the map of the Geological Survey is altogether misplaced, and that that map requires correction, in order to render it an accurate guide to the local geology.

NOTES AND QUERIES.

Human Remains near Knaresborough.—Dear Sir,—The accompanying note may interest some of your readers, and will, I hope, receive elucidation from some of your correspondents.—Yours truly, Homo Fossilis."

Near Knaresborough, in a cavity of the limestone strata, twenty-seven feet below the surface, remains of six human skeletons were discovered imbedded in fine alluvial clay, which was covered with large water-worn boulders. This cave, or fissure, is described as a natural cavity in the limestone rock, seven feet wide, five feet high, and of considerable length; it communicated with the surface by an irregular perpendicular fissure, wide enough to allow a full-grown man to pass. A small spring of water trickles down the side of this opening, and is lost in the porous limestone below. The skull of a dog, and jaw-bone of an ox were found with the human bones; no vestiges of works of art were observed. The provincial paper ("Harrowgate Herald," October, 1852), from which this account is taken, suggests that these remains are of persons who sought for refuge in this cave from their enemies, and being discovered by the latter were stoned to death! An ingenious idea, certainly. One of the skeletons is said to be of a young adult woman.

Slickensides.—Noticing, after the late thaws, in riding by railway to town, as I have often done before, that the numerous slips of earth in the embankments and cuttings presented at their planes of separation and slide smooth and polished surfaces very like, if not indeed identical with, ordinary "slickensides," I have thought a mere note of these common occurrences might convey to many others that which they have seemed to suggest to myself, that slickensides on the large scale might often be due to no other more complex cause than the effects of wet and the natural sliding action of mere subsidence. —Ed. Geol.

Suggestion respecting Provincial Museums.—Among the valuable contributions to science published by the Government Ordnance Survey, one is an Essay on the Educational Uses of Museums, from the pen of the late distinguished Edinburgh University Professor, Edward Forbes. In this essay I find the following passage.

"When the inquirer goes from one province to another, from one county to another, he seeks first for local collections. In almost every town, of any size or consequence, he finds a public museum; but how often does he find any part of that museum devoted to the illustration of the productions of the district? The very feature which of all others would give interest and value to the collection, which would render it most useful for teaching-purposes, has in most instances been omitted, or so treated as to be altogether useless. Unfortunately, not a few country museums are little better than raree shows. * * * Curiosities from the South Seas—relics worthless in themselves, deriving their interest from association with persons or localities—a few badly stuffed quadrupeds, rather more birds, a stuffed snake, a skinned alligator, part of an Egyptian mummy, Indian gods, a case or two of shells—the bivalves usually single, and the univalves decorticated—a sea-urchin without its spines, a few common corals, the fruit of a double cocoa-nut, some mixed antiquities—partly local, partly Etruscan, partly Roman and Egyptian—and a case of minerals and miscellaneous fossils; such is the inventory and about the scientific order of their contents."—Edward Forbes, on Educational Uses of Museums, page 13.

The state of things here referred to by Prof. Forbes, as a general rule will be found more or less to prevail in museums established in towns that are unconnected with men distinguished by their attainments in natural science. We associate the museum at Newcastle with the names of Hancock, Alder, and Hutton; that of York with Harcourt and Phillips; Bristol with Conybeare and Miller; Ipswich with that of Henslow. But many museums exist without the funds for enabling their committees to maintain a permanent scientific officer as curator, and without the advantage of securing for their natural history collections that aid which is within reach of the museums at Newcastle, Ipswich, and other places. In the matter of classification and the determination of species, it is not enough to have the co-operation of those who are willing to give time and to work with hearty zeal. The indispensable element here is knowledge, and knowledge of a kind which few honorary curators can reasonably be expected to have at their command.

Now, if that large class of provincial museums which have but very limited incomes were able to take advantage of temporary competent professional assistance in the arrangement of the collections they possess, the state of things referred to by Professor Forbes need no longer exist. This plan, too, of temporary curatorship has other very strong recommendations. It would put museums all over the kingdom in friendly and beneficial communication with one another, while a system of periodical visitation, especially if combined with the delivery of lectures, would tend to keep alive the local spirit of interest in these educational institutions, which in two many cases is now found to flag, if not to lie altogether dormant. No man of real science going into a provincial museum will look with disdain upon an Egyptian mummy, or upon the fruit of a double cocoa-nut, provided these objects are shown for a definite purpose, and as forming part of a series. But that which every man of science regrets like Edward Forbes is that space and money can often be found for these things when objects of infinitely greater value receive scarcely any attention, or are even altogether ignored.

As it respects the sum total which museums throughout the kingdom have at command after paying such necessary out-goings as rent, wages, etc., if we omit the University museums and a few with incomes sufficient to enable them to maintain men of scientific reputation as salaried officers, the amount collectively may be roughly estimated at £3,000. Now, although £3,000, if divided by the number of existing museums, gives but a small sum to each, yet, if made the most of, it would do a great deal for the accomplishment of those objects which these institutions profess to have in view. £3,000 would more than suffice to pay a staff of men of real scientific attainments, who should have their museum-circuits; and with the surplus, ocean-beds might be made to give up their treasures, and rich fossil-bearing districts be explored. But to do this, museums must recognize the importance of mutual co-operation and the acting upon some common plan. So long as each one acts independently, so long may we expect that the state of chaos so graphically pourtrayed by Prof. Forbes will more or less prevail, and many of these institutions be only theoretically what they might be practically—centres of instruction in science.—E. Charlesworth, F.G.S.

Gems and Precious Stones in Situ.—Sir,—Can you inform me if it is known to what geological formations diamonds, rubies, sapphires, emeralds, or other precious stones belong? Have any, or all of these been found *in situ*; and if so, are they from beds similar or of different geological ages?

I presume they cannot be considered as being of the age of the gravels in which they are usually found, but that they must have been detached from some stratum in the locality from which the gravels themselves were derived. Any information on these points will oblige, yours faithfully, Inquirer.

MAMMALIAN REMAINS AT BRIDLINGTON.—DEAR SIR,—I recently found a fossil Elephant's tusk, embedded in bouldered chalk, in a line with, and adjoining the commencement of the chalk near Bridlington. In consequence of the great pressure of boulder and other drift upon it, it is much crushed; in fact, the longest piece is only six inches in length. There were other fragments *in situ* several inches long, and very thick. Before I disturbed the tusk it measured three feet nine inches, but when I attempted to take it out it fell into pieces.—Yours, etc., EDWARD TINDALL.

SMOKING PIPES FROM THE EXCAVATIONS OF THE SURREY DOCK.—DEAR SIR,—At Greenhithe, or Rotherhithe, near the banks of the Thames, where, for several months last year, the workmen have been digging out a place for a new dock, called the Grand Surrey Dock, they found, at various depths, a quantity of clay smoking-pipes in a bed of undisturbed gravel, which bed of gravel extended all over the dock, and the pipes spoken of were mixed in it here and there all over all that area, at various depths—from twenty to thirty feet from the surface. The pipes, sixteen in number, which have been brought to me are all, with one exception, made out of different moulds; there are not two alike, with the exception just made.

How is it, I would ask, that these pipes have been so distributed as to be found at thirty-six feet below the present surface of the land in that locality? by whom were they made? and how long since?

The above questions are of interest, and perhaps may throw some light on the ancient history of smoking. I may mention that the pipes, with the smaller bowls were found deepest down amongst the gravel, and the diggings were about from fifty to sixty yards from the Thames. Some of the pipes had stems five inches to six inches long, others shorter, all of them more or less mud-stained and broken, but not much water-worn or scratched. A tavern once stood on part of the site of this new dock, which had foundations four feet below the present surface. This tavern was built previous to 1578, and under it, at a depth of fifteen feet below the foundation, some of the pipes were found.—EDWARD TINDALL, Bridlington, 2nd Jan., 1860.

THE RED CHALK OF YORKSHIRE.—For the last two years I have searched for this particular coloured stratum on the western margin of the chalk-hills of Yorkshire, and have found it *in situ*, in a few places, from which also I have extracted fossils. Why I was first induced to look out for this coloured bed was in consequence of knowing its existence at Speeton, and of seeing quoted in Phillip's Manual of Geology, page 12, that Lister had found a species of belemnite (*B. Listerii*), while ascending the Wolds, at Speeton, Londesbro', and Caistor, but always in a red ferruginous earth.

Mr. Wiltshire's paper, "On the Red Chalk" is admirably written, and well worthy of the greatest encomium; however, I find in it a few slight misconceptions as to the range of some of the Red Chalk fossils of our Wolds, to which I will, with your permission, briefly allude.

In that monograph, page 6, it is mentioned that Young and Bird state that "at North Grimstone the coloured chalk seems to be wanting." This, however, is a mistake, or partially so, for I find it developed at a place not far from thence, immediately above the Kimmeridge Clay. I also know of it at other situations not mentioned by other geologists. At page 18 it is said that the *Terebratula biplicata* is very common at Hunstanton, but is not known at Speeton, and that the characteristic fossils of the Red Chalk at Speeton are *Terebratula semiglobosa*, *Belemnites minimus*, *B. elongata*, and at Hunstanton *Terebratula biplicata*, *Belemnites minimus*, and *Spongia paradoxica*. Mr. E. Tindall, of Bridlington, informs me that he has found at Speeton the following fossils, namely, those figured in plate i., figs. 2, 4, 5; plate ii., fig. 4;

plate iii., figs. 2, 3, 4, 7; plate iv., figs. 1, 3, 4, 5, besides many others not figured by the Rev. T. Wiltshire. Hence we have fossils at Speeton similar to what are found at Hunstanton. On the west of our Wolds, where I have met with the Red Chalk, I have procured the *Terebratula biplicata*, *T. semiglobosa*, *Spongia paradoxica*, and Belemnites, etc. Hence we have in Yorkshire what is found in Norfolk, and also what may be brought to light from Lincolnshire. The *Terebratula biplicata* is the characteristic shell where I have searched. However, should any geologist doubt the statement made by me, I shall be ready and most happy at any time to exchange a *Terebratula biplicata* for a fossil from any other formation. Pebbles are also plentiful inland from Speeton.—ROBT. MORTIMER, Fimber, Yorkshire.

FIRE BY FRICTION.—[A note to M. Morlot's paper, page 48.]—I have read somewhere of the dry dead branches of trees crossing each other in a forest taking fire by the see-sawing action produced by a strong wind. I do not know if any such case be authenticated, but if so, or if fire was produced by the friction of dragging timber or felled trees over hard dry ground, the natural imitation of the effect by an untutored savage would certainly be that of artificial friction, or rubbing; and he would as certainly select light thoroughly dry objects, such as sticks, for his purpose. Hence this rubbing of sticks may have been just as, if not even more likely an accidental discovery as the striking of flints or pyrites.—ED. GEOL.

FOSSILS FROM GAINFORD, DURHAM.—SIR,—Would you oblige a beginner in the science, and one who finds it difficult to obtain all the information he might desire through books within his reach, by the name and species of the fossils, the drawings of which are sent herewith. They were found on the banks of the river Tees, near Gainford, Durham. I was struck with the similarity existing between the larger fossil and those figured in your February number, described by Jno. Tate, Esq., as annelides, and named *Eione moniliformis*. At the same time I felt unable to reconcile the idea of their worm-character, with the branchings that seemed to exist, and which were shown more plainly in the slabs as they lay, than in the specimens I brought home with me. One of the drawings sent will illustrate what I refer to. There also seems to be a kind of cirri along one, but the impressions are coarse, and rather indistinct, rendering it difficult to depict it with accuracy. They occurred in flaggy sandstone slate, I suppose it will be in the Carboniferous system.—Yours respectfully, SOUTH DURHAM, Darlington.

These are the same kind of fossils as those described by Mr. Tate, and referred to by our correspondent, whose sketches of the fossils in question are admirable. We refer him not only to Mr. Tate's figures and descriptions, but also to Mr. Hancock's account of similar vermiform fossils in the "Annals of Nat. Hist." (December, 1858). We are inclined to agree with Mr. Hancock that these markings have been produced by the burrowings of small crustacean animals, forming galleries just beneath the surface, the roofs of which have fallen in, leaving furrow-like and beaded impressions. The radiate or brush-like form of marking indicated by one of our correspondent's sketches would belong rather to such galleries, or even to buried fuci, than to annelidal crawling-tracks.

THE GEOLOGIST.

APRIL, 1860.

GEOLOGICAL LOCALITIES.—NO. I.

FOLKESTONE.

BY S. J. MACKIE, F.G.S., F.S.A.

(*Continued from page 90.*)

WHAT a sliding, slipping, torn, and rugged ruinous heap is that far-famed Copt Point itself, with its ravines of shattered clay-splinters, and its shivering peaks and promontories. How the rotten clay breaks and crumbles away beneath your foot-tread, and goes scat-

Lign. 13.—*Belemnites Listeri.* From the Gault.

tering down in multitudes of leaping, racing, bounding chips on to the hard and sea-worn rocks below. Pyritous casts of Ammonites, amber-like Belemnites, and phosphatic casts of Nuculæ, with

their two prominent muscle-marks, strew the cindery-looking ground; while here and there, like horny flakes, are the thin angular shell-pieces of Pollicipes.

Little from its present shattered state is to be got from the blue clay at Copt Point, but it was a rare field for fossils in days gone by, when the weather was allowed, like the sea, to do its work. I well remember one blustering autumn day, when equinoctial gales were blowing hard and strong, stemming the fierce "south-wester" all along the rugged shore from Dover to this point, where with eyes red and half blinded with the cutting wind, seating myself on a block of gault, and chopping with my hand-pick at what I thought were bits of wood, until picking up a fragment in a little mass of clay, I found to my horror I had been innocently demolishing a nearly perfect crab. This incident to this hour fills me with regret for the vandalism I so unconsciously perpetrated. I mention it, however, not to perpetuate my misfortune, but to warn others to look closely to their work if they wish to get good specimens of those four or five species of crustaceans which abound in this stratum. As they are ordinarily sold by dealers, the carapace of the body and some few segments of legs and claws are all that are offered to us; but I am satisfied that if care had been taken, very many of the now mutilated specimens could have been extracted in a nearly perfect state, as the limbs being long and tender, and generally slightly separated from the body, they are, I believe, from the rough way in which these fossils are usually extracted, commonly left unnoticed in the matrix.

Crustaceans of large size and lobster-like form occasionally occur; and one remarkably beautiful specimen, probably an Astacus, or of an allied species, was obtained from this locality some few years since by Mr. S. H. Beckles.

As we proceed towards Baker's Gap, the Lower Greensand gradually uprises; down this gully a miniature winter-torrent—the draining of the impervious gault-lands behind—cascades over jutting rocks amidst the long rank sedgy grass, and trickles—now lost, now bubbling up—amongst the sea-worn pebbles of the narrow beach below. How ruinous the scene! Piles of huge half-worn boulder-rocks, undermined and fallen out from the stony strata and intervening sandy beds of the Lower Greensand, which in a

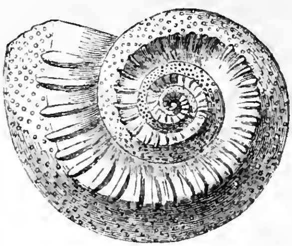
greenish-yellow mouldering cliff extends from hence towards the Harbour; great pouts and heaps of shattered clay, outslips of the narrowing wedge-shaped seam of gault above, line the cliff; while forests of dank olive sea-weeds hang limp like drooping fringes over ledges of rough massive rock and jutting ridges of the stony seams as they outcrop through the clattering shingle, over which the foaming waves, spurting and hissing in the cavities and caves formed by the piled rocks, spatter their seething spray for the keen sea-breeze to scatter like diamond drops of dew on all the damp and clammy objects around.

On the Lower Greensand we do not purpose here to dwell, except to say that although from the hardness and compactness of the stone-beds, the incoherent state of the sands, and the general friableness of the shells, its fossils can only be obtained in a fragmentary state. They are, however, highly interesting; and any geologist who wants work to do may usefully employ himself in making out the stratigraphical details and zones of characteristic fossils in the strata of the uppermost division which ranges along the cliff from Copt Point to the Harbour, and is continued to the westward of Folkestone in the beautiful rugged cliff that scarps the high level grassy platform of the Lees, on which the new and handsomest part of the town of Folkestone is built.

In such researches the smallest fragment of a shell or bone, or any other fossils, has its proper value,—I never want to teach people to look for pretty or fine things, but by God's blessing to do useful work,—in obtaining efficient results, which should be carefully compared with the stratigraphical range of the like fossils in the lower greensand deposits on the Continent and elsewhere; the chief value of such an inquiry being to determine the relations in time of the various portions of the greensand formation with each other, or their synchronism with certain portions of other Cretaceous beds in different localities, and to increase our knowledge of the physical circumstances under which the lowermost members of the Cretaceous Formation were accumulated.

But to return to those fallen heaps of purple gault. Damp and wet with the rain and the spray, they are rich harvest-fields for the geologist. Split and crack those great unshattered lumps; cleave

them with your pick; break them in their lines of lamination with your hammer; knock them or cut them to pieces how you will, they are teeming with fossils; every fresh surface exposed is glittering with the pearly iridescent nacre of crushed or flattened shells: nine-tenths of the fossils, and even more, are in this compressed and distorted state. Never pause in your work of destruction, for what you leave undone in that way the sea and the weather will very speedily accomplish. The elements are certain to destroy all, good, bad, or indifferent, matrix and fossils: you may save some glorious treasures. Go to work, then, stoutly, but mind, only when the gault is *damp*; it is of no use cracking and shattering the hard grey lumps dried in the summer's sun. In the arid droughts of that season you may recline on those stony rocky ruins, and listlessly cast pebbles in the sea, for the lustrous nacre of the shells will have dessicated into the whiteness of mere carbonate of lime, and the intractable gault will fracture into hundreds of little dice-like fragments, but the fossils, tight-gripped in the hard and shrunken clay, can never be extracted.

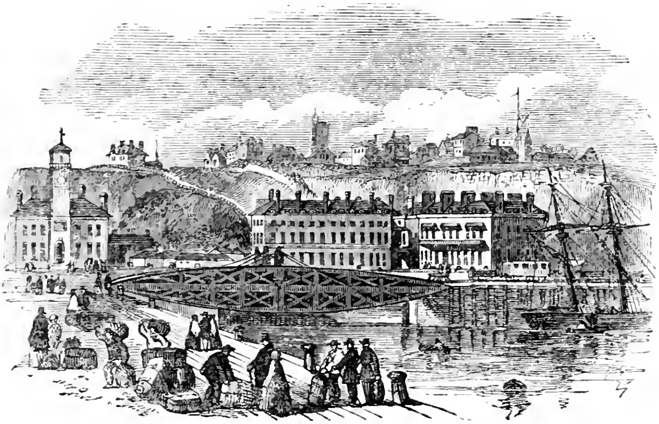


Lign. 14.—*Solarium ornatum*. From the Gault.

It were glorious work, that work of destruction, if it were only for the gratification of the eye alone in the resplendent show of the scores of yellow golden crumpled Inocerami and Ammonites which every fresh broken purple surface exposes; but there are treasures every now and then to be bagged, or basketed—for I always use a fisherman's basket, with a square hole in the lid, strapped over my shoulder, as the handiest object for the purpose, and as the best both

for the preservation of the fossils and for their easy carriage. All the fossils are not crumpled and distorted, and every here and there are perfect Nuculæ, fine large Ammonites, often four to six inches across, Sea-urchins, *Rostellaria Parkinsonii*, *Solarium conoideum*, and *S. ornatum*; and now and then one meets with the rarer shells, such as *Scalaria Clementina*, *Mytilus*, and pretty small Turrilites.

Passing on to the west side of the town, we find the greensand cliffs attaining a height of about one hundred and twenty feet, and capped only by a few outlying rusty patches of gault, and a stream



Lign. 15.—Lower Greensand Cliff, on the west side of Folkestone Harbour, with capping of Mammaliferous Drift.

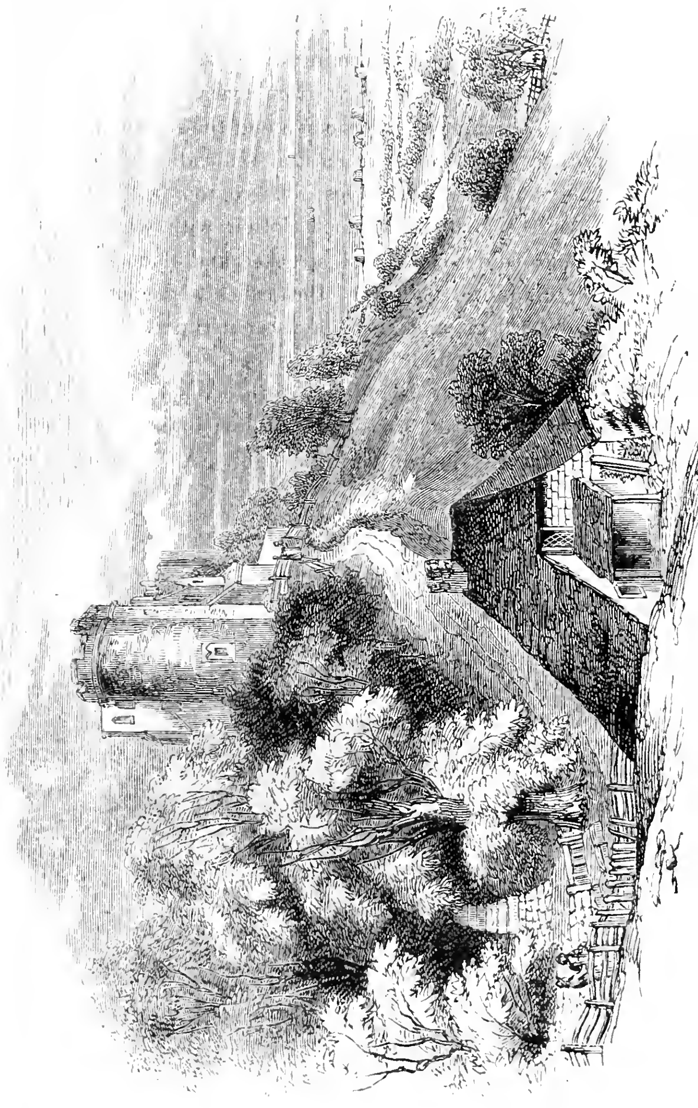
of mortar-like nodules, the weathered remnants of the "junction-bed," extending for about half a mile beyond the Lees. Even this capping has been denuded out from the site of the Battery, at the back of the Pavilion Hotel, and its place supplied by a deposit of white marl and flint-gravel, inosculating with or thinning out under a bed of brick-earth. These deposits—the gravel, marl, and brick-earth—have no connection with the greensand on which they repose, being altogether of more modern date and different condition, the former containing the remains of mammoth, hippopotamus, hyæna, Irish elk, deer, and oxen, and others of the great mammalia.

From the Lees the greensand-cliff ranges westward, presenting a bold, rugged face, with jutting beds of warm greenish-yellow stone, glowing in the sun's bright beams, and looking ruddier in their contrast with the dark bushes of intermingled gorse and the tufts of thyme and other plants which grow from every sandy seam. A pretty walk it is on a summer's afternoon along the foot-way. Below is the turnpike-road and the great natural sea-wall of fallen rocks, resisting still the buffets of the waves. There, too, below us is the broad expanse of the British Channel, dotted with white sails of freighted ships and fishing-boats, and streaked and clouded with the paddle-foam of smoking steamers. Butterflies and moths flutter amongst the rank herbage, and grasshoppers chirrup along the bank that bars us from the level and fertile fields.

As we approach Sandgate, the pretty little village with its long street of straggling houses and its round castle set in its ring of semicircular lunettes bursts suddenly on the sight. A charming view

Lign. 16.—Sandgate, from the end of the Folkestone Cliffs. The foreground consisting of the upper, the mid-distance behind the village of the middle division, beyond, in the distance, the Kentish rag-beds of Hythe.

indeed it is from this abrupt termination of the Folkestone cliffs. A steep path, skirting a Martello-tower—for these round forts extend for miles along the coast—winds down to the village beneath, at the



Lign. 17.—The Archiepiscopal Palace at Lympne, with the flat alluvial region of Romney Marsh at the base.

back of which rise other cliffs of dark green irony water-holding sand, that of the middle division, marked everywhere in its course by the prolific growth of equisetacea and of ferns.

From Seabrook the limestones and rag of the lowest division of the Greensand rise towards Hythe, in a grass-covered cliff, occasionally quarried for building and lime-burning, and gradually becoming higher, until at Lympne we look from another lofty headland over the flat map-like country of the Marsh, with its lines of dykes and

Lign. 18.—"Jill's Pipe." The junction of the Lower Greensand and Weald Clay.

water-courses. As we descend this promontory, past the stalwart ruins of the ancient Roman castrum, we cross what I believe are the Neocomian sands, below the ragstone-beds, and a pretty spring of water, which streams away by a rustic wooden gutter, marks the junction of the sand with the impervious weald-clay beneath.

Some readers may doubtless wonder why I have wandered all along this pretty coast to Lympne's old ruined Roman castrum, which may appear, perhaps, to them to be as little connected with the Folkestone gault as the Mansion House with St. Pauls. Nevertheless, there is some "reason in my madness." To the student e nbued with the love of nature the science of geology offers at once a sublime and unlimited expanse: he is in a transport of delight at every step with the knowledge he obtains. Every new opening and unfolding of the great book of the past overwhelms him with the immensity of the ideas and reflections which arise. He has acquired a new language, as it were, and can read the stirring stories recorded in the ponderous volume. To the world, occupied with its cares and trials, its anxieties, or its pleasures, the volume lies open spread, but few or none read the language in which it is written. So when we isolate a locality, and attempt to teach its geology to the mass, we must treat our subject as a simple story—as one simple incident in the eventful past. We must have a oneness of purpose, a sturdy truth, which however we may attempt to grace it, must be the lesson we have to teach. I have read in some old Danish writer's tale of one Trimalchio, who had his epitaph written on a sun-dial, that everybody who consulted it might read his name. With worthier purpose I hope to engrave some solemn truths on these pages, which, gentle reader, form our meeting-place, and by as pleasantly as I can, making a book of science one of amusement also, tempt you to come where these truths may be read. "A fisherman must bait his hooks to the taste of the little fishes, if he expects to catch them," and philosophers will never succeed by dry and arid language in tempting those who seek for recreation and instruction after the labours and duties of life. For such I write, for those who with elastic tread and hearts lightened in holiday time of their ordinary daily duties are seeking recreation in the innocent study of God's works and renovated health in the cool breezes from the sea; these I presume *not* to know the geologic history of this blue clay band. For their sakes it has been that I have rambled all along the shore to show them how the Gault forms one section of the great Cretaceous group, of which those other strata, although so different in their mineral character, form also parts.

I have pointed out also the capping of brick-earth and ossiferous marl on the West Cliff, to show to the inexperienced student that the juxta-position of strata is no proof of relationship; but that beds of earth lying together in proximity may be far removed from each in the dates of their formation, and indeed may belong to very different causes and events. In this case, as in others, the fossils are the true medals of the past; and here they teach us that while the cretaceous rocks exhibit from top to bottom the dominion of the sea in a remoter age, the marls and brick-earth were not deposited until after the marine sediments of the cretaceous rocks had been first raised into dry land, and then denuded or worn away—sliced off—to the extent of at least a thousand feet in vertical height; and that while the former group belongs to the mid-period of the earth's history, the latter is of recent date, but just preceding if not coeval with the first appearance of man, for the fossils it contains are those of the great terrestrial beasts, with the remains of which in other places the flint-implements and other traces of his works are found. Let us then briefly tell the story of those events—it has been often told before, but no matter, everyone has not heard it, and even those who have delight to dwell upon it—and those ancient physical conditions with which the geological history of the gault is associated. The consecutive chain of events is as readily conceived as it is plainly to be traced.

First, the old dry land of oolitic rock, with its thick umbrageous forests, and its enormous river pouring into a delta—rivalling that of the Ganges—sediments that formed the Wealden beds, sank gradually below the level of the sea, and the great accumulation of the lower greensand took place. The depression of the land still going on, the finer deposit of mud reached higher on the sinking coast, and encroaching on the sands as they sank deeper and deeper beneath the waves, the Greensand became covered by the Gault. The upper greensand would seem to indicate a temporary elevation, or at least a shoaling of the water. Again, a further sinking carried the once dry ground to the depths of the ocean, where in the quietest calm of the abyss lived those little Foraminifers, whose tiny shells chiefly form the mountain mass of chalk.

The Portland-stone, on which rest the Wealden beds (of fresh-

water origin), is covered by its ancient soil, with the stems of the trees erect as when they grew. This was the ancient land, first transformed into a delta, into which the old mighty river poured its flood. Here lived the gigantic Iguanodon; here the Pterodactyles—winged lizards—flitted in the dusky twilight; birds waded in the mud; the hum of insects was heard in the air. All, all the strange beings of those ancient days have perished, and two thousand feet at least of solid earth is piled above their tomb.

(To be continued.)

ON CANADIAN CAVERNS.

By George D. Gibb, M.D., M.A., F.G.S., Member of the Canadian Institute.

The prominent feature of a large portion of the province of Canada is the presence of various limestone rocks belonging to the Silurian formations. Until lately, the existence of caverns in these rocks, as well as in those lying subjacent—namely the Laurentian of Sir William Logan, was almost unknown; as, with the exception of an isolated account here and there, no regular description of any cavern had appeared. Owing to the labours of the Canadian Geological Survey, and of several private individuals, a number of caverns have been discovered at distances remote from one another; some of these have received but a passing notice in the publications of the Survey, and are not, therefore, useful as a means of reference. The present communication, it is hoped, will supply that deficiency, as in it I purpose to embody short descriptive accounts of all the caverns of Canada which are known up to the present time. The details of some of them are not so full as could be desired; nevertheless, with all the available sources of information within my reach, together with personal observation in some, on the whole the general descriptions may be relied upon as accurate, and as containing a correct account of the particular geological formations in which they lie.

For convenience of description, it may be here stated that the boundaries of the province of Canada are at the present time as follows:—North by the Hudson Bay Company's territories, and shores of James' Bay; on the west by Lakes Huron, Superior, Lake of the Woods, Winnipeg, and Red River; South by Lakes Erie and Ontario, and the states of New York, Vermont, and New Hampshire; and to the eastward by the River and Gulf of St. Law-

rence, the state of Maine, the province of New Brunswick, and the eastern coast of Labrador; the whole extending between the latitude of forty-two degrees and fifty-five degrees north, and longitude fifty-six and ninety-eight west.

The caverns of Canada may conveniently be divided into two classes; the first comprises those which are at the present time washed by the waters of lakes, seas, and rivers, including arched, perforated, flower-pot, and pillared rocks, which have at one time formed the boundaries or walls of caverns, and all of them unquestionably the result of aqueous action. The second comprises caverns and subterranean passages which are situated on dry land, and so far as we know, not attributable to the same cause in their origin as the first, or at least not applied in the same manner.

In the first class are included the following:—

1. Caverns on the shores of the Magdalen Islands.
2. Caverns and arched rocks at Percé, Gaspe.
3. Gothic arched recesses, Gaspe Bay.
4. The "Old Woman," or flower-pot rock, at Cape Gaspe.
5. Little River Caverns, Bay of Chaleur.
6. Arched and flower-pot rocks of the Mingan Islands.
7. Pillar sandstones, north coast of Gaspe.
8. Niagara Caverns.
9. Flower Pot Island, Lake Huron.
10. Perforations and caverns af Michilimacinac, L. Huron.
11. The Pictured Rocks, Lake Superior.
12. St. Ignatius Caverns, Lake Superior.
13. Pilasters of Mammelles, Lake Superior.
14. Thunder Mountain and Paté Island Pilasters, L. Superior.

In the second class are:—

15. The Steinhauer Cavern, Labrador.
16. The basaltic caverns of Henley-Island.
17. Empty basaltic dykes of Mecattina.
18. Bigsby's Cavern, Murray Bay.
19. Bunchettes Cavern, Kildare.
20. Gibb's Cavern, Montreal.
21. Probable caverns at Chatham, on the Ottawa.
22. Calquhouns Cavern, Lanark,
23. Quartz Cavern, Leeds.
24. Probable caverns at Kingston, Lake Ontario.
25. Mono Cavern.
26. Eramosa Cavern.
27. Cavern in the Bass Islands, L. Erie.
28. Subterranean passages in the Great Manitoulin Island, Lake Huron.
29. Murrays Cavern and subterranean river, Ottawa.
30. Probable caverns in Iron Island, Lake Nipissing.

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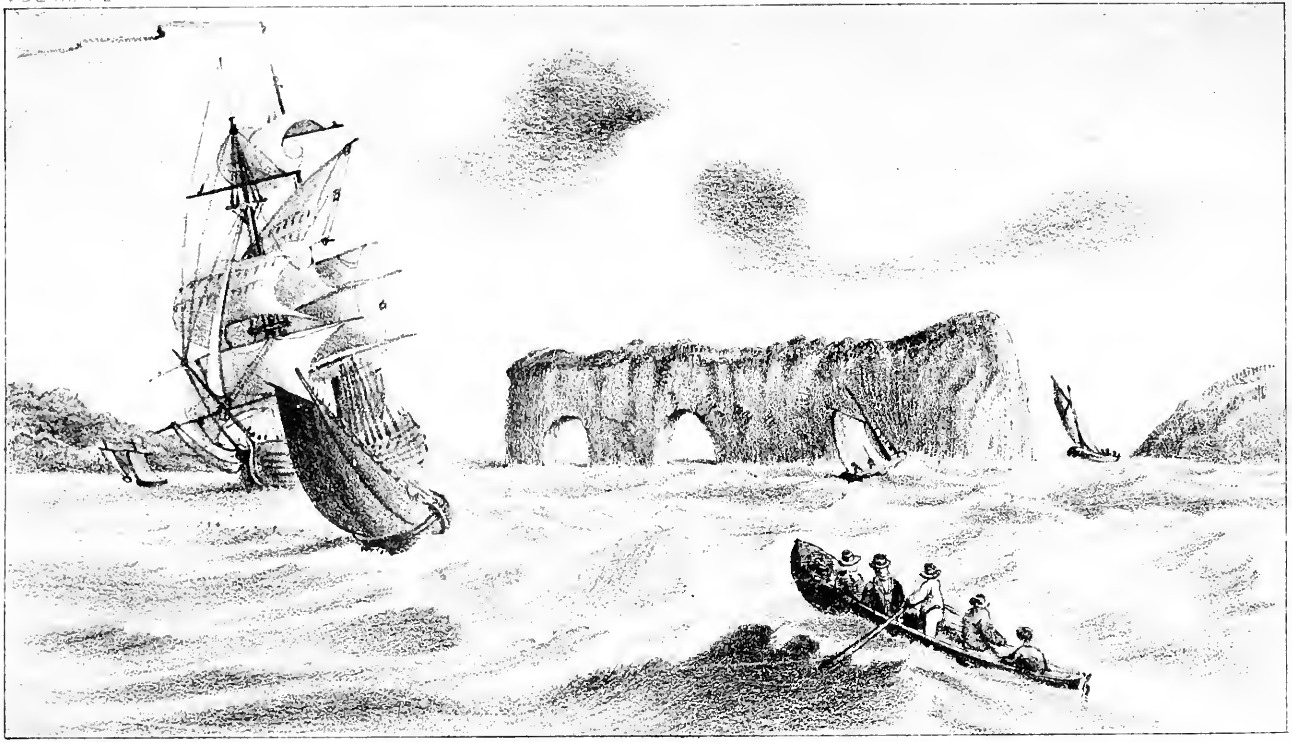


[illegible] PIERCED ISLAND, REMARKABLE [illegible]
IN THE GULF OF ST LAWRENCE

The majority of those in the first class are on a level with the water, whilst the remainder are elevated above, varying from a few to upwards of sixty feet.

In the second class the level varies, but nearly all are above that of the sea, and, as will presently be described, none penetrate the earth to a considerable depth; but this may be found to be otherwise as the explorations are continued. In none have animal remains been found, excepting in one instance, and they were discovered loose and not imbedded in stalagmite; and so far as I am aware, not a single object, such as a flint arrow-head or spear, used by the ancient inhabitants of the country, has been observed. This circumstance may in some measure detract from the present communication; that part of the inquiry has still to be worked out, as many of the caverns have been but very partially explored, indeed some have scarcely been examined and as several of them branch off by means of fissures and galleries, running from distinct chambers (most of the latter containing stalagmite) we may yet hope for interesting discoveries, particularly in that district of country in which exist the huge caverns of Mono and Eramosa in the Niagara limestone rocks of the Upper Silurian formation. The researches of my friend, Mr. Sterry Hunt, of the Canadian Geological Survey, have shown that these limestones are essentially dolomitic, and thus perhaps favourably constituted for the development of caverns.

(To be continued.)

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London, *February* 29, 1860.—L. Horner, Esq., President, in the Chair.

"On the Lower Lias of the South of England." By Dr. T. Wright, F.G.S.

The author first stated that the uppermost beds of the Lower Lias are those containing *Hippopodium ponderosum*, and that the lowest beds are those with *Ammonites Planorbis*, overlying a series of strata containing *Estheria*, &c., which he separates from the Lias, under the name of the *Avicula contorta* beds. The last rest on the grey and red marls of the Keuper.

Dr. Wright then proceeded with the description of the *A. contorta* beds, including the "Bone-bed," having first enumerated the authors who have written on these and the equivalent strata (Kössener, Shichten, etc.,) on the Continent. The sections at Garden Cliff, near Westbury on the Severn, at Wainlode Cliff, at Aust Cliff, at Penarth, near Cardiff, at Uphill near Weston-super-Mare, at Culverhole near Axmouth, at Wilmcote and Binton near Stratford-on-Avon, were described in detail as illustrating this series; and General Portlock's section of these beds in the North of Ireland was also alluded to. *Pecten*

Valoniensis, *Cardium Rhæticum*, and *Avicula contorta* are the chief molluscan fossils of this zone.

The next group of strata are those with *Ammonites Planorbis* and *Am. Johnstoni*. Some of the foregoing sections expose these beds, such as those at Uphill and Wilmcote; but they can be still better studied at Street in Somersetshire, where they have yielded so many fine Enaliosaurian fossils. These beds are also well exposed at Brockeridge and Defford in the Vale of Gloucester, and at Binton in Warwickshire.

Isastræa Murchisonæ occurs in this zone, and *Ostrea Liassica* is very characteristic of some of its lower beds. *Ichthyosauri* and *Plesiosauri* of several species are found in this series; the latter chiefly in the lower part. Of the two known specimens of the *Pl. megacephalus*, one was found in these beds near Street, Somerset, and the other at Wilmcote, Warwickshire.

The *Ammonites Bucklandi* characterizes the next higher group of strata, which are also known as the Lima-beds. These are well seen at Lyme Regis, at the Church Cliff, and from the Broad Ledge to the shore, and yield several species of *Ichthyosaurus*, also *Am. Conybeari*, *A. rotiformis*, *A. angulatus*, *A. Greenoughii*, and *A. tortilis*.

The *Am. Turneri* beds are next, and can also be studied at Lyme Regis; they have yielded three species of *Ichthyosaurus*. *Am. semicostatus* and *A. Bonnardi* belong to this zone.

The *Am. obtusus* beds succeed, between the Broad Ledge at Lyme and Cornstone Ledge near Charmouth; they apparently have no saurian fossils. *A. Brooki*, *A. stellaris*, *A. planicosta*, and *A. Dudressieri* accompany *A. obtusus*.

The next zone is that of the *Am. oxynotus*, with *A. bifer* and *A. lacunatus*. The beds with *Am. raricostatus* comprise, in ascending order, the Ammonite-bed, the Hippopodium-bed, the coral-band, and the Gryphæa-bed. This zone is well seen near Cheltenham, at Lyme, and at Robin's Hood Bay in Yorkshire. *Am. armatus*, *A. nodulosus*, and *A. Guibalianus* belong to the *A. raricostus* beds.

Dr. Wright then pointed out that the *Avicula contorta* beds, like the Kössen beds, contain a fauna special to themselves, and might as well be classed with the Trias as with the Lias. They have a wide range in the South of England, South Wales, the Midland Counties, and the North of Ireland. After some remarks on the more important features of the several Ammonite-zones of the Lower Lias, the author concluded by remarking that as Quenstedt and Oppel had observed, the Middle Lias could be similarly subdivided by means of the Ammonites peculiar to its several stages.

Liverpool Geological Society, *March* 13, 1860.—Thomas Urquhart, Esq., in the Chair.

The Secretary, G. H. Morton, Esq., F.G.S., exhibited a number of scratched boulders, and shells of several species collected by him from the boulder-clay of the district. He showed how the boulders were connected with the grooved and striated surfaces of the sandstone in the neighbourhood.

Thomas I. Moore, Esq., of the Derby Museum, exhibited Cetacean remains from more recent local deposits.

The Rev. Henry H. Higgins brought forward his proposal for the arrangement of the recent and fossil species, in the new Liverpool museum, in natural history series, without regard to stratigraphical formations. The Secretary, Dr. Collingwood, and most of the members of the society, advised a geological arrangement of the fossils. It was suggested that the Society should enrich the valuable geological collection of the Royal Institution, which, with some small additions, would assume considerable importance.

Manchester Geological Society, *February* 16.—On this day the members of this Society made an excursion to Burnley, under the direction of the President, Sir James Kay Shuttleworth, Bart., F.G.S. After the dinner, the President described the valuable seams of coal under the Gawthorpe estate, and Mr. Pickup described the strata at the pit belonging to Messrs Thursby and Scarlett at Spa Clough. Mr. Binney drew attention to the bed of *Unio robustus* as being two hundred yards above the Habergham, or assumed Arley mine of Full-edge; whilst at Wigan the same bed was only forty-seven yards above the Arley-mine. In the dining-room were displayed Mr. Wilds' excellent collection of fossil fish-remains from Full-edge, and shells from the Lower Coal-measures, as also extensive and valuable collections of fossil plants from the Burnley Coal-field belonging to Messrs Whittaker and Birtwell. Mr. J. Mushen of Birmingham exhibited some beautiful casts of cystideans.

Ordinary Monthly Meeting, February 28.—A paper was read on "Over-Winding in Coal and other Mines," by Thos. Wynne, Esq., F.G.S.

NOTES AND QUERIES.

Mr. Page's Handbook of Geological Terms.—We have received a considerable number of communications upon various points of pronunciation. We have reserved these for a time, with a view to their publication together in our next number. We hope, therefore, that any intended suggestions or remarks may be forwarded to us early in the present month.

Limestone Veins in Shale at the Base of the Old Red Sandstone.—Sir,—A few days since I observed some irregular vertical veins, or thin dykes of dark grey compact limestone, crossing a nearly horizontal bed of red shale in and near the local base of the Old Red Sandstone, which rests unconformably upon beds very seldom, and then but slightly calcareous. The shale in which they were observed is separated from the overlying Carboniferous Limestone by a considerable thickness of yellowish sandstone, of which over two hundred feet is exposed. As these veins do not contain fossils, and there is nothing else to show that the limestone was derived from organic sources, while the thickness of the intervening sandstone is against the supposition that it was deposited by infiltration from the Carboniferous Limestone. Perhaps you, or some of your other readers will say how an occurrence so unusual may be accounted for.—I am, etc., A. B. W., Templemore.

Biblical Chronology of Man.—Sir,—In reference to the *vexata questio* of the age of man on the earth as connected with the works of human art lately found in France, one point of consequence has, I think, been hitherto overlooked, viz., that we are not confined by the authority of the Bible to the period of six thousand years for the date of man's creation upon the earth. Phyres Clinton, in the appendix to his "Fasti Hellenici," mentions the fact that most of our old Bible manuscripts vary much in their chronology, chiefly in the duration of life assigned to the patriarchs before the Flood, and also before the time of Abraham. So considerable is this variation that I believe I am not far wrong in stating that twelve thousand, or even twenty thousand years

may be obtained for the period since man's creation from some of these manuscripts; and I believe also that Mr. P. Clinton stated that there was no preponderant rate of authority for the manuscripts which had been followed by the authors of our Bible translation. The Septuagint translation, *e.g.*, was founded on a different set of manuscripts; and I think also that Josephus is said to have had some quite different from ours. I write only from recollection, not having the books at hand to refer to; but I am sure of this point, that on the authority of some of the manuscripts of the Bible, a much longer period may have elapsed than the six thousand years which are generally received. I conceive that the possibility of such an extension of time might extend also the probability of man's having been coeval with even the mammoth.—I am, Sir, Yours obediently, (The Rev.) S. C.

Provincial Geological Museums.—Sir,—I was well pleased to see the remarks of E. Charlesworth, F.G.S., in reference to Professor Forbes suggestions for establishing "Educational Museums." I presume there is scarcely a Geological Society in the kingdom but has a nucleus, at least, of a museum in the shape of one or more cabinets of "specimens," collected from the various strata of their surrounding districts. What we students of Geology now require is to have published in your excellent magazine a list of all the Geological Societies of the kingdom, and a list of the specimens collected in their separate districts. There would be no difficulty in obtaining this information, if you, sir, suggested to the secretary of each geological society to forward to you a short account of their local strata, &c., and the fossils found therein. By the publication of such information, the readers of your magazine would become acquainted with a circle of fossil districts, would know to what society they should write for exchanges, or what spot to visit to enrich their cabinets or local museums; a friendly feeling would be generated amongst the various geological associations, and considerable practical information obtained. We cannot expect that societies will give up independent movements since they must be guided in some measure by local circumstances; but if the teachers of geological science would lay down a practical plan for the formation of provincial geological museums and mutual co-operation, I have no doubt but that the various associations would at once act upon the suggestions.—Yours faithfully, G. Horner, Glasgow. We concur in the desirableness of the publication of the lists suggested by our correspondent, and shall be obliged to the various secretaries and members of institutions and societies for the necessary information.

Quaternary Geology.—An interesting discussion occurred at the ordinary meeting of the French Geological Society, on November 7th, which is reported in the Bulletin for January last. M. Gaudry produced specimens which he had recently dug from the diluvium in the neighbourhood of Amiens. He stated that he had found axes nearly in contact with fossil mammalian bones, together with small pierced balls, which M. Rigollet considered to be necklace beads, but which did not with certainty show traces of human art. In reply to a question from M. d'Archiac, M. Gaudry said the axes were not all found lying horizontally but at various inclinations and mostly together. M. Desnoyers confirmed these statements having aided in the explorations, and explained that many of the implements were formed from rolled pebbles. He considered the deposit to be a fluviatile one; it contained, in beds of sand interstratified with the gravel, Cyclades, Ancylus, Paludina, and Limnæa, and could not be due to tumultuous causes. M. d'Orbigny cited an instance at Bicêtre of a diluvial gravel bed capped by a fluviatile sand under the Loess. M. Desnoyers explained the fluviatile character of the deposit by its occurrence at the confluence of a side valley with the Somme, and maintained that the mammalian bones had been rolled, which M. Jourdain also stated was the case.

M. Hebert referred to the well known discoveries of M. Perthes and the labours of Mr. Prestwich, and others, resulting in the production of upwards of a thousand implements from deposits certainly quaternary, characterized by *Elephas primigenius* and *Rhinoceros tichorinus*. He denied that they had been subsequently disturbed, described them as covered by a red diluvial clay, with broken flints usually unrolled, identical with the red diluvium of the neighbourhood of Paris, and that the brick-earth, or loess, was superimposed. He maintained that it is impossible that the flint implements could have been introduced into their actual present position subsequently to the deposit of the two last named beds. Doubtless the implements were not rolled as were the bones. In all cases the axes lie under the double mantle of the red clay and loess, showing beyond all question that they belong to the antecedent state of things. If then we admit with M. d'Archiac that the loess is the result of a general deposit independent of the centres, whence the rolled gravels with elephant bones have radiated; that the great extension of Alpine glaciers is subsequent in date to the loess, that the turbaries are more recent still, we are obliged to conclude that the existence of man in the north of France belongs to an epoch more ancient than the quaternary!

The identity of the brick-earth with the loess, the local chrracter of upper gravels, require careful consideration before we accept this as the true place of the first-art stratum; but in the present state of our knowledge it may be useful to call attention to the sayings and doings of our neighbours.—S. R. P.

HETEROSTEGINA-BED.—I should be much obliged if you could let me know which is the "Heterostegina-bed" at Malta mentioned in the paper read at the meeting of the Geological Society, Jan. 4th, by Mr. T. R. Jones.—Yours truly, F. W. HUTTON, Staff College, Aldershott.—In Capt. Spratt's notice of the geology of Malta, &c., in the Geological Society's Proceedings, vol. iv., p. 226 and p. 230, the "yellow sandstone" is described as being full of a "very thin Nummulite," referred to also by Prof. Forbes as the "*Lenticulites complanatus*." It is this bed which is now known as the "Heterostegina-bed," and Mr. Rupert Jones has favoured us with the following remarks on the subject.

"The thin Nummulite-like shell, found in the dark-yellow friable stone, is not a Nummulite nor a Lenticulite. It belongs to the Heterostegina of D'Orbigny; a genus which is related to Nummulina and to Operculina; but it has its chambers subdivided, and is not symmetrical in its growth. The yellow sandstone is the second great stratum from the top of the Tertiary series of beds at Malta, and is well seen at several places in that island and in the cliffs at Ranella Bay, in Gozo. Besides the *Heterostegina depressa*, D'Orb., this rock contains *Globigerina bulloides*, D'Orb., and a few other Foraminifers. The *Lenticulites complanatus* of Basterot (to which the Maltese fossil above mentioned has been erroneously referred) being really a very thin Operculina, the name "Lenticulites" (which is inapplicable in other cases also) is disused. Operculina is a sub-genus of Nummulina.

Dr. Wright has followed Spratt and Forbes in misnaming this Heterostegina "*Lenticulites complanatus*" (Ann. Nat. Hist. Qter., vol. xv., p. 103, pl. 7, f. 4.). The latter name was given by Basterot to a large thin discoidal fossil Foraminifer from Bordeaux, now well known as an Operculina, similar to such as now exist in the sea at the Phillipines, Australia, and elsewhere. *Operculina complanata*, however, also occurs at Malta, for Lord Ducie has favoured the writer with a fine specimen in a very hard white limestone from that island."

ON THE DIVISIONS OF THE DRIFT IN NORFOLK AND SUFFOLK.—"As I shall have frequent occasion to make use of the word diluvium," wrote the late Dr. Buckland, "it may be necessary to premise that I apply it to those extensive and general deposits of superficial loam and gravel which appear to

have been produced by the last great convulsion that has affected our planet."* Omitting any opinion upon the cause of those deposits, Sir Charles Lyell gives the following definition of the diluvium: "Those accumulations of gravel and loose materials which by some geologists are said to have been produced by the action of a diluvian wave, or deluge, sweeping over the surface of the earth."† More recent opinions upon the presumed agencies which have brought together the heterogenous materials forming the gravel and clay beds, and deposited and spread them over their present sites, have led to the adoption of the term "drift," as more significantly expressing the modern views held on their mode of transport. The "drift," therefore, includes the series of beds of gravel, sand, loam, and boulder-clay, or till, the latter being but a northern provincial term for the former.

My late friend, the highly intelligent geologist, Joshua Trimmer, whose well known intimate acquaintance with these superficial deposits, from an extended examination, has given high authority to his remarks upon them, was the first to adopt, if not to originate, their more defined division into "lower drift, till, or boulder-clay," "upper drift," and "warp of the drift."‡ My respected friend afterwards divided his lower drift—till, or boulder-clay—into an upper and lower boulder-clay; founding this division upon what he and others had observed in the Suffolk cliffs, at and near to Gorleston. During the many agreeable gossips that I had with my late friend, I heard his views in relation to the above-mentioned divisions, and as frequently combated them, from not having observed anything in West Norfolk to warrant them; and since my residence at Yarmouth, after having repeatedly examined the cliff from Corton to Gorleston, and other localities, I have seen nothing to shake my scepticism upon the subject. Trimmer wrote thus: "It appears that in the Gorleston cliffs there are two boulder-clays, separated by a mass of sand, which, on the authority of Woodward, has hitherto passed for the 'crag,' a term which has now become as indefinite as that of 'drift,' or 'drifts.' The lower boulder-clay is the tailing off of that so well known for its blocks of Scandinavian origin, and which extends over the north of Europe and into the eastern side of England. The upper boulder-clay is characterized by an abundance of oolitic detritus;" and he proceeds to say that, "the former overlaps the latter, with a mass of sand interposed."§

It appears from the perusal of this cited paper that there were anomalies in the structures of the superficial beds "which had perplexed" Mr. Trimmer; it also appears that these perplexities were removed by meeting with (for thus he wrote) "some boulders of gneiss on the beach; and though during a rapid examination we found none actually embedded, Mr. Gunn assured me he had seen them in the cliff."‖ From having repeatedly examined these cliffs, and having also dug into the so-called lower boulder-clay, or till, without meeting with a boulder of any kind *in situ*, I cannot assent to the existence of two boulder-clays—an upper and a lower.

Beneath the sand underlying the true boulder-clay a highly ferruginous loam, stained in places black by decomposed vegetable matter, exists. Into this bed I dug to the depth of about five feet, and a trench, three feet by two, without meeting with anything but one portion of black flint, about the size of my open hand, with its angles rounded, and pebbles and small angular fragments of

* Reliquæ Diluvianæ, p. 2. 1823.
† Glossary in "The Principles of Geology."
‡ "On the Geology of Norfolk, &c." published in the Journal of the Royal Agricultural Society of England, vol. vii., part 2. 1847.
§ "On the Upper and Lower Boulder-clay of the Gorleston Cliffs." Quart. Journal of the Geological Society, vol. xiii. 1857.
‖ Op. cit.

flint, but not a vestige of any primitive rock. This loam contains an abundance of very small fragments of tertiary shells, resembling those from the crag, as also does the sand above it. The boulders of gneiss met with on the beach by Messrs. Trimmer and Gunn, we may venture to believe, had previously fallen from the boulder-clay above; and those seen by Mr. Gunn embedded in the cliff, I am disposed to think, were driven in and covered up by violent tides prevailing on that shore, having first fallen from above, and been carried out to sea by retiring waves. Neither after frequent iterations of long-continued examinations of the drift in West Norfolk; the written reports of an intelligent well-sinker upon the beds passed through in forty wells, chiefly in West Norfolk, with a few extending into the centre of the county; nor from the examinations of Dr. Mitchell* have I been able to obtain any information that would lead me to believe in the existence of two boulder-clays.

Both in the gravel-beds and boulder-clay throughout the counties of Norfolk and Suffolk large and small rolled masses of primitive rocks are almost everywhere met with, so that the occurrence of them on the Gorleston beach is to be expected, and therefore they prove nothing towards the definition of two boulder-clays there.

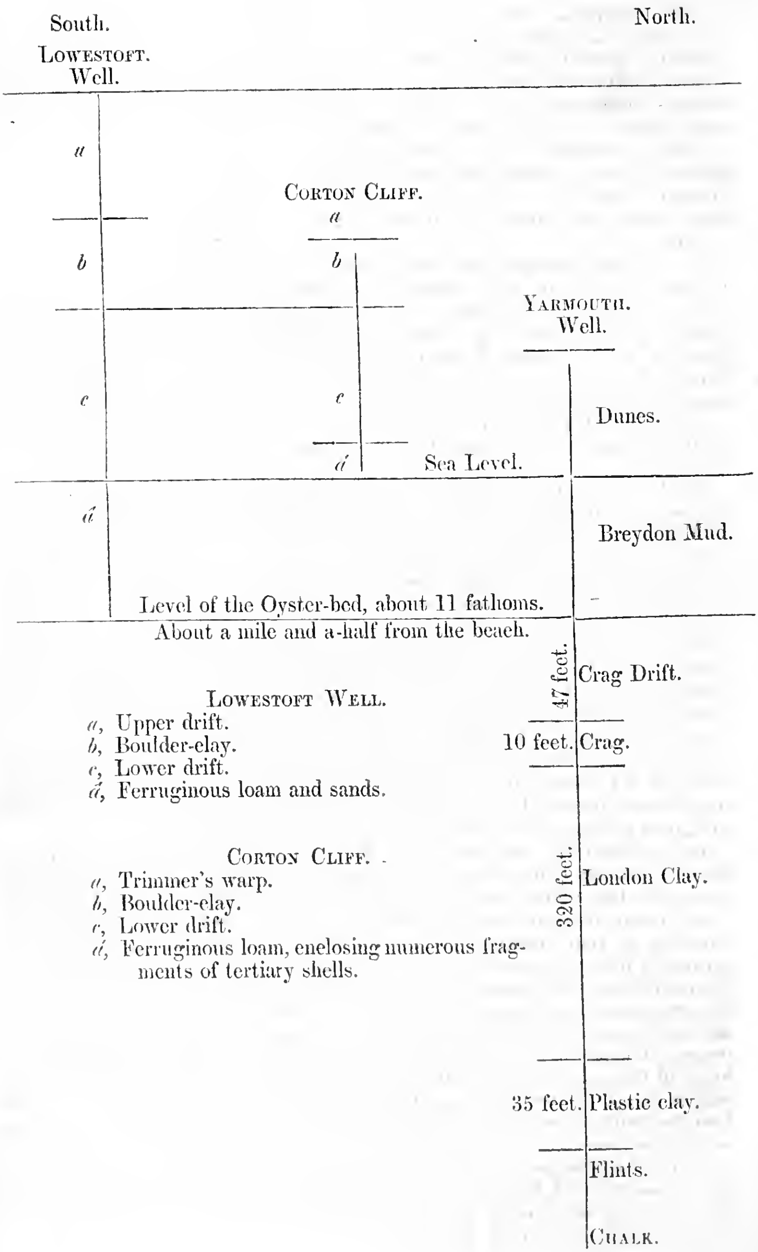
Recently I have taken opportunities of examining into the superficial strata, from the drift above the boulder-clay successively down to the chalk. In the first instance at Lowestoft, where the upper drift, boulder-clay, with the underlying sand and loam have been opened; next at Corton Cliff, where the boulder-clay, with the subjacent sand, and the so-called lower boulder-clay are visible in the cliff; then at Gorleston, where but a small seam of boulder-clay beneath the vegetable soil covers the under-lying sands, and where the loam beneath is rarely visible; lastly, where a well has been bored down into the chalk. Surely, in this last instance, had a lower boulder-clay existed, some indications of it would have been brought to light.

The diagrams of sections (p. 140) will illustrate the above descriptions, and assist in the comprehension of my view of the divisions of the Drift in Norfolk and Suffolk.

To the north of Yarmouth, at Caister Castle, at Ormsby, and the neighbouring villages which I have examined, the boulder-clay is again seen capping the inferior drift-sands, it having been removed from them by denudation at the embouchure of the three rivers, Waveney, Yare, and Bure, at Breydon Broad. At Ormsby, in a brick-yard, the ferruginous loam of the lower drift is met with nearer the surface, not enclosing a single boulder. To the west of the seashore, about five miles inland from Lowestoft and Corton, and at Somerleyton brickfield, also at Barnby and Ellough, near Beccles, the boulder-clay is seen covered by the upper-drift, and "warp of the drift," of Trimmer. At Somerleyton, in the brickfield, a well has been sunk in the loam and sand beneath the boulder-clay to the depth of forty feet; and these beds have been opened horizontally to nearly the same depth to procure brick-earth, without meeting with a boulder of any kind, nor even a flint-stone of a size adapted for paving; nothing but small angular shingle and pebbles.

In West Norfolk the boulder-clay lies for the most part immediately upon the chalk; but when a bed of sand or gravel intervenes, no fragments of tertiary marine shells are to be found in it, as in similarly placed sands in East Norfolk, the former bed lying beyond the western and northern margin of the crag formation. The position of the boulder-clay near to the surface is shown with surprising accuracy upon Smith's Geological Maps of Norfolk and Suffolk by the dark drab-colour used for designating the heavy lands in those counties. If I may presume to suggest an alteration of my late esteemed friend's divisions

* "On the Drift, &c.;" by J. Mitchell, L.L.D. Geological Proceedings, vol. iii., p. 2.



Lowestoft Well.

a, Upper drift.
b, Boulder-clay.
c, Lower drift.
d, Ferruginous loam and sands.

Corton Cliff.

a, Trimmer's warp.
b, Boulder-clay.
c, Lower drift.
d, Ferruginous loam, enclosing numerous fragments of tertiary shells.

of these superficial beds, it will be into the following order, viz., upper drift, boulder clay, and lower drift.

The Upper drift consists of beds of gravel formed of rounded flint, sandstones, quartz-rock, gneiss, syenite, and granite, as pebbles rather than boulders, accompanied with a greater or less quantity of ferruginous sand or sandy loam. In this division I include Trimmer's "warp of the drift," considering its formation but the termination of one long period of deposition, diffusion, erosion, denudation, and re-arrangement of the materials, and lastly, I conceive that by the surging of muddy waves, the final adjustment was accomplished immediately anterior to or just as that portion of the earth was emerging from the water.

The Boulder-clay has a well-marked distinctive character in its great proportion of oolitic and chalk-boulders, all more or less rounded and scored; also in the almost entire absence of stratification in the bed. This clay occurs either as a bed of blue, drab-coloured, or marly clay, these modifications arising from the predominance of the parent Kimmeridge, Oxford, and blue Lias-clays, or the prevalence of the clays of the Inferior and Great Oolites, or the superabundance of the detritus of the Chalk with its flints; for in this clay boulders occur derived from all the oolites and from the various rocks of the cretaceous system, with a comparative sprinkling only from the primitive division of rocks.

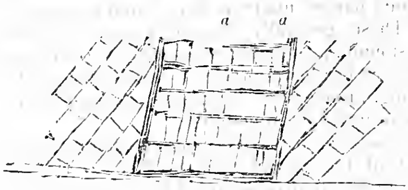
The Lower Drift is found to be stratified alternations of sand, gravelly-shingle, and ferruginous-loam with angular fragments and pebbles of flint embedded in it. The layers of shingle in the sand consist of very small fragments of Tertiary shells resembling those of the Crag. I consider the period during which these post-tertiary beds were depositing as one epoch; but why the agency of icebergs should have occurred whilst the boulder-clay only was depositing I will leave to other theorists to enunciate the reason.

The organic contents of the beds sunk and bored through at the Yarmouth Brewery well are, first, in the Breydon-mud, *Ostrea edulis*, *Cardium edule*, *Tellina planata* of Pennant, *Tellina Bathica*, and *Pecten opercularis*. In the Lower-drift, what I am disposed to call in this instance Crag-drift, fragments only of tertiary shells are found; in what I have called the Crag in the section *Mytilus edulis*, *Tellina Bathica*, and a part of a *Balanus*; in what Mr. Prestwich called, on his inspection of specimens of the clays, London and Plastic clays, and in whose opinion I fully concur, no shells or fragments of shells were met with, or if any have been found they have not been preserved.

Judging from the products of the Yarmouth Well, and also from those of the well sinkings and horizontal diggings at Somerleyton, I consider it to be established that there is not a second boulder-clay in East Norfolk or Suffolk.

As in some measure connected with the subject of this paper, it may be interesting to your readers to learn whence the mammalian remains are so constantly dredged up on this coast, and also what they are. The Oyster-bed from which they are brought up with the living oysters I have laid down in the accompanying section; it occurs at from a mile and a-half to two miles from the beach, and at a depth of about eleven fathoms. They consist of teeth and bones of the skeletons of two species of mammoth, teeth of Hippopotamus, heads of the male and female *Megaceros Hibernicus*—an atlas of the megaceros with a *Turritella incrassata* impacted in the canal of the vertebral artery, has been met with, a horn-core of *Bos primigenius*, and one with a vertebra and metacarpal bone of *Bos longifrons*, jaw with teeth of *Equus caballus*, cervical vertebra of a Grampus, and a lower jaw, without teeth, of a Walrus—the last is in the possession of Mr. Owles of this town, in whose collection, in that of Mr. Nash residing here, and in my own, the above named fossils are preserved.—C. B. Rose, F.G.S., Great Yarmouth.

Errata in Mr. Du Noyer's Paper on the Giant's Causeway.—Dear Sir,—Please to call attention to the following typographical errors in the paper on the Causeway. Any practical geologist seeing lign. 7, p. 10, called "The Whin Dyke," would at once perceive the error. No dyke of basalt ever assumed the appearance given in lign. 7 when vertical, but it might if it were horizontal, when, however, the columns would be more regular than those shown in the figure I allude to. The peculiar character of *all* trap-dykes is



Silurian Slate. Trap Dyke. Silurian Slate.

their tendency to columnarize at right angles to their walls, or cooling surfaces; while what may be termed *joints of shrinking (a a)* become very numerous and close at the edges of the dyke. In many instances the dyke at its sides decomposes into a soft brown shale.

At p. 11 the allusion to lign. 7 refers to lign. 6.—Yours very truly, Geo.! V. Du Noyer.

Notes of Fossiliferous Localities of the Old Red Sandstone of the East of Scotland.—Should any amateur geologists, delighting in a pedestrian excursion, relieved occasionally by a little rail and steamboat travelling, be desirous of visiting the fossiliferous districts of the Old Red Sandstone of the east coast of Scotland during the ensuing season for rambles, I think the following remarks may be of some service in the search for specimens. The trip, by using a little despatch, will take about five or six weeks; to go thoroughly to work, and obtain a perfect knowledge of the localities, &c., would require at least five or six months. However, I was not able to spare more than six weeks, and during that time I visited all the most important places of interest to the geologist in that part of Scotland, with tolerably fine weather, and without being overburdened with baggage, but possessing a very useful and moderate-sized hammer (a small hammer is of no use in this district) and a couple of stone-chisels (large and small); with these tools you can encounter a nodule of almost any size; but the hammer itself will generally prove sufficient, unless the nodule breaks crossways.

At the end of these rough remarks I have given a list of all the Old Red fishes found in Scotland, with the locality of each species; this may be useful, to enable the tourist to know what species are to be met with in the places he visits. I have taken each place in the order I visited them, commencing with

Cromarty, the locality rendered famous by Hugh Miller, as the first examined by him in his researches on the Old Red Sandstone, nearly thirty years ago. There are many species found here, but rarely any in a remarkably good state of preservation; the most abundant appear to be the *Diplacanthus striatus* and a *Cheiracanthus*. Large numbers of sea-worn nodules containing the remains of fishes may be picked up on the coast at low water, especially after rough weather; these seldom contain anything very fine. I searched nearly a whole day with very little success; however, the next day I was more fortunate in procuring several good specimens by digging some two or three feet in one or two beds on the shore containing the nodules. These were some of the beds that Hugh Miller used to visit in his geological rambles. It is not,

however, every nodule found here that contains a fish, or even part of a fish, for which reason they ought to be opened on the spot, and it will be found that about 70 per cent. contain nothing of value. The fish here preserved are generally of a black colour.

About four miles south of Cromarty is the Burn of Eathie, a locality often visited by Miller. Just at the point where it enters the sea, and for one hundred yards north and south of the burn, on the shore, numbers of nodules may be found, but of a much harder material and of much larger size than those we have described. These generally contain plates of *Coccostei*, rarely other species; but occasionally a tolerable specimen of *Glyptolepis* may be opened. These nodules are very much waterworn. A little farther to the south are the Lias beds, containing numbers of *Belemnites*, *Ammonites*, &c., which are also found on the shore in water-worn nodules.

From Eathie I proceeded to Nairn, which is about nine miles west of Elgin, and is on the coast of the Moray Frith. Close to this town are Boath and Kingstep quarries, in which may be found the remains of *Bothriolepis*, *Asterolepis*, &c., but in the most fragmentary form—all in detached pieces, separately embedded. The matrix is of a very loose granular friable nature; in colour very similar to the rock at Scatcrag. It is especially friable when wet; but the upper portion of the rock is of a more compact and close texture, and is much employed in the neighbourhood for building-purposes. This upper stratum contains no fossils, although numerous cavities, round and oval in form, of various sizes, from half an inch to four or five inches in diameter, and in depth about a quarter of an inch are found in this rock. I could not, however, detect any traces of organic remains in them, and they appear frequently to be filled with a clayey material, which falls to pieces in laminæ when taken out.

From this place I visited Lethen Bar and Clune, inland places, about ten miles from the sea at Nairn, the nearest road being through some splendid forests of Scotch fir and beech, in which are presented some of the most beautiful and variously coloured fungi I ever have seen; some are of large size (six or eight inches in diameter), and their fine pink, orange spotted with white, purple, and other colours have a beautiful appearance in contrast with the grass and green bog-moss in which they lie in profusion. A ride round about this district is delightful at the fall of summer.

The fishes of Lethen Bar and Clune are enclosed in nodules of the same character as at the other localities, but of a harder and more compact texture, and nearly round, similar to those of Gamrie, but much larger, and having a tinge of red, produced by oxide of iron. They are embedded in great plenty in a clayey material of a brownish-red colour; it would be a mistake, however, to suppose every one to contain a fish, or even a portion of one, although fragments are in much greater profusion than whole specimens. When a nodule contains an entire fish, a few gentle blows with the hammer round the edge will cause it to split readily, disclosing, perhaps, a *Pterichthys*, with its arms extended, and scales of red, blue, and white in brilliant contrast with the matrix—entombed for ages upon ages, yet retaining its symmetry as perfect as when first entombed in what was then a sandy but now a stony sepulchre—appearing more like a painting on stone than the remains of an extinct and extraordinary fish.

Some species of fish found in the Old Red Sandstone are almost always (the exceptions being very rare) in a greatly distorted state, this being probably caused either by the struggles of the animal, the contortions of the body after death, or by the action of the sea on the sand after the decomposition of the internal parts of the fish had taken place. The fishes most generally found in this state are the *Diplacanthus*, *Acanthodes*, and *Cheiracanthus*; all these genera of fishes possess very minute scales and large well-marked spines. Perhaps

some of your readers will be able to account in some measure for the circumstance that such fishes with very minute scales should be so much distorted, while those with larger scales are not so generally distorted, the only exception being the *Glyptolepis*. This fish, with larger scales than most of the fishes of the Old Red, is often found greatly distorted. In the *Acanthodes pusillus* the head and tail are generally contiguous; sometimes the fish looks as if tied in a knot, and often as though in one roundish mass it had been crushed endways. Some of the other species in similar manner have their spines protruding in all directions around. Such examples are not peculiar to this locality, but are also found in other places. Some of the magnificent specimens in Lady Gordon Cumming's collection contain two or three *Pterichthys* on one slab. Of the *Pterichthys* there are many species found here, some in a splendid state of preservation, perhaps superior to those from any other place whatever.

ELGIN.—About nine miles from Elgin is Nairn, which is the best place to stop at while visiting the Old Red Sandstone beds in the vicinity, Scat Crag being about four miles distant to the south. I first went there. This locality is well known for its large variety of interesting fossil remains, although generally these are found in fragments. The matrix is of an extremely loose and friable conglomerate of very coarse sand and pebbles; the fossils (for the most part detached scales, plates and portions of plates and teeth, &c., of various species) are very plentiful, but the greatest possible care is requisite in obtaining them perfect from the matrix, the fossils being as friable as the conglomerate in which they occur, often crumbling in the hand with the slightest touch. Large scales of *Holoptychius giganteus*, &c., are to be obtained here, nearly four inches in diameter, as are occasionally pieces of jaws of *Bothriolepis*, &c., and many interesting portions of bones, supposed to have belonged to *Pterichthys major*. It has been recommended, as a means of preserving these fossils from falling to pieces, to let the specimens remain a short time in gelatine, and then carefully to dry them.

In the Elgin Museum are some very fine specimens from this locality, and a very good collection of Old Red fossils. Patrick Duff, Esq., of Elgin, has also a beautiful collection from this neighbourhood.

At FINDRASSIE, about a mile from Spynie, and two and a-half from Elgin, scales, scutes, and bones of *Stagonolepis*, &c., are found. This quarry is not worked now, but good specimens may yet be obtained from amongst the heaps of rubbish lying about.

The hill of SPYNIE is about two miles from Elgin, and is a huge mass of sandstone. It is the place where the unique specimen of *Telerpeton Elginense* was discovered, no other specimen of this reptile having been found.

At SLUIE, on the Findhorn, a few miles from Elgin, many fine specimens have been found, such as scales, teeth, plates, &c., of the several species found at Nairn, Scatcrag, &c.: these also are in detached fragments. Some very fine teeth of fishes of large size have been discovered at this locality, but are extremely rare.

About seven miles north of Elgin is the MASONHAUGH-QUARRY, a place famous for the footprints of animals supposed to be reptilian. Numbers of slabs are to be found with such impressions, some of them small, about two inches in length, with about an eight or nine inches stride between them; others, again, are of gigantic size, some impressions being fifteen inches in length, and ten in breadth, and exhibiting a stride of fully five feet. This is the only place in Scotland where these footprints are found.

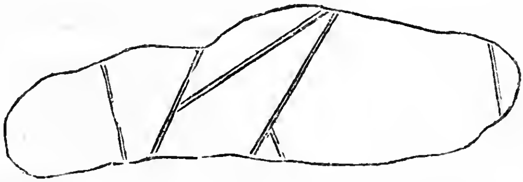
LOSSIEMOUTH is about six miles north of Elgin; the quarries there present a light greyish white and yellowish stone, precisely the same in texture and colour as the rock at Dura Den, but containing only, as far as has yet been discovered, bones and scutes of *Stagonolepis* and *Hyperodapedon*. As some

of our eminent geologists have of late been disposed to regard this rock at Lossiemouth as not being part of the Old Red Sandstone series, but as being of the Triassic period, I should much like to know whether the Dura Den sandstone is to be considered of the like age, instead of what it was lately supposed to be, the upper old red; and if it would be probable, or possible, to find the several species of the black beautifully preserved fishes, or any of them, in either the upper or lower part of the strata, containing the bones and scutes, at Lossiemouth, or *vice versâ* at Dura Den, the white bones with the black fishes? This has somewhat puzzled me: the sandstones appear to me to be precisely the same, but the fossils at present known are totally different. In the Elgin Museum are some fine slabs, containing bones of *Stagonolepis* and *Hyperodapedon*, from Lossiemouth.

Tynet Burn fish-bed is about three miles east of Fochabers, which latter is a few miles eastward of Elgin, on the east bank of the river Spey. The fish-bed lies about thirty feet above the burn. The fishes found there are for the most part in an excellent state of preservation, and are of several species. They are found in flatter nodules than at the other localities, and are of a light greenish grey colour. These nodules are imbedded in a greyish clayey marl, from which they may be taken out in great numbers. They vary in size from half an inch to a foot in diameter; one half of them not containing more than a mere scale or two, especially the large ones. Some, however, contain very fine and perfect specimens; and in the very small nodules are found that extremely minute fish—the smallest of the Old Red fishes—the *Acanthodes pusillus*; but I have sometimes opened above twenty without finding any trace of a fish. However, in some of the smallest, not larger than a shilling, I have found a beautiful little fish, less than half an inch long, with its characteristic spines beautifully preserved. The average length of this species is about one inch and a half. On opening the nodule the fishes appear in beautiful contrast with the matrix, being white, red, and blue in colour, similar to those of Lethenbar.

One of the rarest fish here is the *Pterichthys*, at least I found it so, for I obtained only one or two fragments. The same also with the *Coccosteus*: this fish-bed is now nearly worked out, His Grace the Duke of Richmond having lately had a party of labourers engaged in laying open a large section of it, and very few specimens are now to be obtained. There is a bed lower down the stream, known as the "Coccosteus-bed;" but few specimens have been obtained from it there.

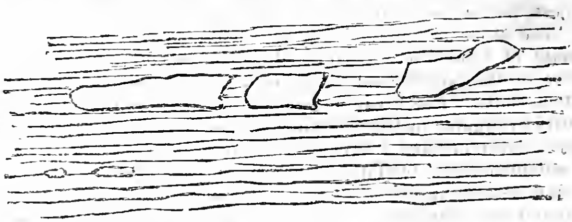
The nodules at Tynet have frequently bands of crystallized calcspar running across in several directions, sometimes only in one, right across the nodule, causing it often to break in many places (see lign. 1). Many of these nodules



Lign. 1.—Nodule from Tynet, with seams of calcspar.

are found in the bed broken in two or three places, lying from half an inch to six inches from it counterparts (see lign. 2). This is another reason for opening the nodules on the spot as they are dug out, otherwise, perhaps, you will

leave the best half in the bed, as the halves of the nodules are generally rounded at the edges, and would easily pass as perfect nodules.



Lign. 2.—Disjointed nodules, with the pieces lying apart in the rock.

Crossing the river at Fochabers, and bearing a little to the left, we come to DIPPLE. The fishes from thence are now found in nodules scattered over the fields of the neighbourhood, the original bed discovered by Dr. Malcolmson, about twenty-three years ago, being covered up with soil, and seemingly quite exhausted of its fossiliferous nodules. These nodules have a botryoidal form, and are of a deep red colour; the fossils are entirely in fragments, and very few. The rocks on the Dipple side of the Spey, seen from Fochabers, near the bridge, are of a deep red colour, very hard, compact, and granular in texture, and much used in the neighbourhood for building-purposes.

GAMRIE is about eight miles from Banff, and forty from Elgin, and is a rich locality in many species of fishes; some of them, especially the *Pterichthys oblongus*, are there in a very good state of preservation. The *Cheirolepis uragus* is rather rare, and many of the nodules contain what seem to be coprolites.

These nodules are extremely hard and difficult to open, and have the fibrous crystalline structure at the edges more distinct than those at other places. They are of a brownish colour, the fishes as generally preserved being of a darker brown. These nodules are embedded in the same kind of laminated clayey marl, as in the other localities; the bed containing them is situated about a quarter of a mile from the sea-coast.

In many of the nodules the centre, instead of containing a fish, is filled with small rhomboidal crystals of calcspar, also with a dark brown bituminous matter in a thin oily form.

DURA DEN is much more to the south than all the last-mentioned localities, being about two miles from Cupar, in Fifeshire, and is celebrated for its finely-preserved fishes, which are all different from those in the other fossiliferous deposits of the Old Red. Two new species have very lately been discovered there, the *Phaneropleuron Andersonii* and *Glyptolæmus Kinnairdii*.

Some of the slabs obtained from this locality contain a dozen or even twenty fishes, but these are almost entirely of one kind—*Holoptychius Andersonii*, a species which well exhibits the peculiar characters of the genus. One of the most interesting fish discovered here is the *Pamphractes Andersoni*, a fish much resembling the *Pterichthys*. This sandstone is of a yellowish or greyish white colour, similar to the rock at Lossiemouth.

CLASHBINNIE is nearly opposite to Newburgh, on the north side of the Tay, and is the locality where that magnificent specimen of the *Holoptychius nobilissimus*, in the British Museum, was found. Scales of *Phyllolepis concentricus* and *Holoptychius Murchisoni* are also found here. The matrix is of a deep red, while the fossils are of a whitish colour.

The deposits of the Lower Old Red in the ORKNEYS and at CAITHNESS are

extraordinarly abundant in fish-remains of upwards of thirty species. The fossil fishes are of a black colour, and some in a very high state of preservation, but usually they are extremely fragmentary. The fossils are not found in nodules there, but are seen on the flags, or slabs, as they are removed from the quarries. The stone is almost black, or sometimes brownish, and contains a large amount of bituminous matter. In some places it is quarried for the manufacture of the paraffine-oil, which is obtained by simple distillation from the sandstone slabs. This great amount of bitumen seems to be owing to the vast quantity of organic matter contained in this sandstone. Many of the slabs have an oily appearance and a strong bituminous odour.

In the neighbourhood of THURSO are several quarries, where many fishes may be found, as also near STROMNESS, in Pomona. In some of the sandstone slabs are found small nodules; these are formed by a nucleus of iron-pyrites.

In the neighbourhood of Edinburgh, at BATHGATE, large quantities of paraffine-oil is manufactured from the refuse bituminous minerals and rubbish from the coal-pits of the neighbourhood.—JAMES R. GREGORY.

LIST OF FOSSIL FISHES FOUND IN THE OLD RED SANDSTONE OF SCOTLAND.

Acanthodes pusillus—Tynet, Dipple.
Actinolepis tuberculatus—Scaterag, Findhorn.
Asterolepis minor—Scaterag.
——— *Malcolmsoni*—near Nairn, Scaterag.
——— *Asmusii*—Thurso.
Bothriolepis ornatus—Findhorn, near Nairn, Scaterag.
——— *favosus*—Clashbinnie, Scaterag.
Cephalaspis Lyelli—Glamis, Carmylie.
Cheiracanthus grandispinus—Orkney.
——— *microlepidotus*—Lethen, Tynet, Cromarty.
——— *minor*—Tynet, Moray, Orkney.
——— *Murchisoni*—Gamrie.
———*pulverulentus*—Orkney.
Cheirolepis Cummingii—Lethen, Moray, Cromarty, Tynet.
——— *curtus*—Lethen.
——— *macrocephalus*—Orkney.
——— *Traillii*—Orkney.
——— *uragus*—Gamrie.
——— *velox*—Orkney.
Clinatius reticulatus—Balruddery.
Coccosteus cuspidatus—Gamrie, Cromarty, Orkney, Eathie.
——— *decipiens*—Lethen, Tynet, Cromarty, Thurso, Orkney, Dipple, Eathie.
——— *maximus*—Lethen, Tynet.
——— *microspondylus*—Orkney.
——— *oblongus*—Lethen, Tynet.
——— *pusillus*—Orkney.
——— *trigonopsis*—Orkney.
Conchodus ostreaeformis—Scaterag.
Cosmacanthus Malcolmsoni—Scaterag.
Cricodus incurvus—near Nairn, Scaterag.
Dendrodus latus—Findhorn, Scaterag, Moray.
——— *strigatus*—Findhorn, Scaterag.
——— *sigmoideus*—Scaterag.
Diplacanthus crassispinus—Moray, Orkney.
——— *gibbus*—Orkney.

Diplacanthus longispinus—Lethen, Cromarty, Tynet.
———— *perarmatus*—Orkney.
———— *striatulus*—Lethen.
———— *striatus*—Cromarty.
Dilopterus affinis—Gamrie.
———— *borealis*—Thurso, Orkney.
———— *gracilis*—Orkney.
———— *macrocephalus*—Lethen, Tynet.
Dipterus macrolepidotus—Tynet, Thurso, Orkney.
Glyptolepis elegans—Gamrie.
———— *leptopterus*—Lethen, Tynet, Scatcrag.
———— *microlepidotus*—Lethen.
Glyptolæmus Kinnairdii—Dura Den.
Glytopomus minor—Dura Den.
Gyroptychius angustus—Orkney.
———— *diplopteroides*—Orkney.
Holoptychius Andersonii—Dura Den.
———— *Flemingii*—Dura Den.
———— *giganteus*—Findhorn, Scatcrag.
———— *Murchisonii*—Clashbinnie.
———— *nobilissimus*—Findhorn, near Nairn, Scatcrag, Clashbinnie, Thurso.
———— *princeps*—Scatcrag.
———— *Sedgwickii*—Orkney.
Homothorax Flemingii—Dura Den.
Lamnodus biporcatus—Findhorn, Scatcrag.
———— *Panderi*—Scatcrag.
———— *sulcatus*—Scatcrag.
Osteolepis arenatus—Gamrie, Cromarty.
———— *brevis*—Orkney, Thurso.
———— *macrolepidotus*—Tynet, Cromarty, Thurso, Orkney.
———— *major*—Lethen, Tynet, Dipple.
———— *microlepidotus*—Thurso, Orkney.
Pamphractus Andersonii—Dura Den.
Parexus incurvus—Babruddery.
Phyllolepis concentricus—Clashbinnie.
Placothorax paradoxus—Scatcrag.
Phaneropleuron Andersonii—Dura Den.
Platygnathus Jamesonii—Dura Den.
———— *paucidens*—Orkney.
Pterichthys cancriformis—Orkney.
———— *cornutus*—Lethen.
———— *hydrophilus*—Dura Den.
———— *latus*—Lethen, Tynet, Gamrie.
———— *major*—Findhorn, Scatcrag.
———— *Millerii*—Lethen, Gamrie, Cromarty, Orkney, Eathie.
———— *oblongus*—Gamrie, Lethen, Cromarty, Eathie.
———— *productus*—Lethen, Tynet.
———— *quadratus*—Gamrie, Cromarty.
———— *testudinarius*—Cromarty.
Tripterus Pollexfenii—Orkney.

Mr. C. T. Gaudin on Dr. Falconer's late Researches on the Extinct Species of Rhinoceros.—(From the Bulletin de la Société Vaudoise, No. 44, p. 130, June 1859.)—I have received from Dr. Falconer some interesting details of his recent palæontological studies, which I think will throw some

light upon the connection between the lignites of Dürnten and the contemporary deposits of other countries.

The learned English palæontologist, while exploring the caverns of Glamorganshire, discovered numerous remains of a rhinoceros, distinct from the *R. leptorhinus* of the Norwich Crag, and the *R. tichorhinus* of the glacial deposits. The rhinoceros which Dr. Falconer names *R. hemitœchus*, on account of the half separation of the nostril, which is its characteristic feature, is associated with the *Elephas antiquus* in the Glamorganshire caverns. It is also met with at Grays Thurrock, and other places in the newer pliocene deposits of the Thames Valley. There it is always associated with the *Elephas antiquus* and the *Hippopotamus major*; while in the more ancient beds near Norwich the *E. meridionalis* and the *R. leptorhinus* are always found together.

In the museum at Pisa are to be found the remains of the *R. leptorhinus* and *R. hemitœchus*. All the molars of elephants preserved there belong to the *E. meridionalis*, with one doubtful exception, which belongs, perhaps, to the *E. antiquus*. The elephant found in the caverns of Palermo is the *E. antiquus*, associated there with the *Hippopotamus major* and *H. Pentlandi*, a smaller species, not yet found on the Italian continent.

Such are the results of Dr. Falconer's researches. It is easy to judge of their importance, if what M. Strozzi and myself worked out in the Val d'Arno be recollected. There we found an exotic flora associated with *R. hemitœchus*, *E. antiquus*, *R. leptorhinus*, and *E. meridionalis*. At Dürnten, on the contrary, we have an existing flora associated with the *E. antiquus*, and, they say, *R. leptorhinus*. This was incomprehensible until Dr. Falconer had given the clue to the solution of the difficulty. He attributes *R. hemitœchus* and *E. antiquus* to the newer pliocene, and *R. leptorhinus* and *E. meridionalis* to the pliocene properly so called. From this it appears probable that the bones of the Val d'Arno, which have been brought together at very different epochs, from unknown deposits, belong to different formations. *R. leptorhinus* and *E. meridionalis* are found in the Pansino, with an exotic flora (*Glyptostrobus Europæus*, *cinnamonum*, &c.); while *R. hemitœchus*, and perhaps the doubtful molar in the museum of Pisa, might come from the upper yellow sands. It is probable that an existing flora will be found associated with these bones. Note also that the Rhinoceros of Dürnten, which is supposed to be *R. leptorhinus*, is in a bad state of preservation, and probably belongs to *R. hemitœchus*. Thus the connection between the flora and fauna of both sides the Alps is reestablished. R. hemitœchus, E. antiquus, Glamorganshire; R. hemitœchus, E. antiquus, H. major, Gray's Thurrock; R. leptorhinus, E. meridionalis, Norwich. At Pisa both these Rhinoceroses and their accompanying Elephants and Hippopotami are found. At Palermo the more recent E. antiquus and H. major only are found.

ON THE RE-OCCURRENCE OF FOSSIL SPECIES AT VARIOUS STRATAL HORIZONS.—Mr. Mark Norman, of Ventnor, has favoured us with some notes on the Lower Greensand and Wealden strata of Brixton and Chale Bays, Isle of Wight. After enumerating some of the repeated occurrences of certain species in the lower greensand, as stated in Dr. Fitton's elaborate table* of the lower greensand fossils, he points out some facts which he has personally observed; and he expresses a hope that some geologists who may have time and means at command will be induced to carry on still further the researches so well conducted by Dr. Fitton for twenty years and more, and thus add to our knowledge of the relations of fossil species, and their distribution in time and space, especially as regards the "recurrence" of species, a subject of much interest and not without its difficulties.

* Quart. Journal, Geol. Soc., vol. iii., p. 289, &c.

After alluding to the single appearance of the *Perna Mulletii*, confined to one group consisting of two beds or zones, and to the frequent appearances of the *Gryphææ* that first occur with the *Perna*, and range upwards through more than four hundred feet of strata, Mr. Norman alludes to the two groups of Crioceras-zones, and to special ranges of other species, some of limited occurrence, some appearing at wide intervals, and some few of rather frequent occurrence throughout many strata. All these particulars may be found in Dr. Fitton's table before alluded to.

Mr. Norman also alludes to the re-occurrence of the wealden *Lonchopteris Mantellii* in the lower greensand, found by Dr. Fitton in seven bands. At Whale Chine in particular (at a distance of about five hundred feet from the Atherfield beds) nodules of ferruginous sandstone, containing Panopœa, Cardium, Natica, Ammonites, &c., abound with the remains of this fern, associated with twigs and branches of trees, all carbonized. Sometimes the fragments and fronds are upwards of two inches long. The nodules are also scattered along the shore as far as Walpen Chine, and a little beyond. Fragments of coniferous wood, and remains of large cycadaceous leaves occur also in these nodules. Mr. Wheeler, of Blackgang has found some good specimens; but the best that Mr. Norman has seen were collected by M. Säemann, of Paris, in a block of red sand-rock, eastward of Blackgang Chine. The iguanodon has also been discovered, says Mr. Norman, somewhere in the same locality; but not having been present when its discovery took place, I cannot state the exact spot. From the character, however, of the matrix adhering to the bones, I am confident as to their having been found in the upper portion of the lower greensand. The teeth and portions of its skull, together with what remained of its skeleton, were forwarded to the British Museum. Some other fine specimens of iguanodon-bones, from the same cliff, have been preserved at Newport, and others at Ryde.

Mr. Norman further remarks that the occurrence of fossil wood, unperforated by teredo in the lower part of the lower greensand, together with fern-fronds, cycadaceous leaves, and the almost complete skeletons of iguanodons, has led him to think that these deposits were mainly derived from river-sediments not far from an old coast-line; whilst the worm-bored drifted wood found higher up in the series would seem to point to a more open sea for the place of the formation of the beds.

Mr. Norman also reminds us of the re-occurrence of the wealden *Clatharia Lyellii* in the upper greensand, and of the condition under which *Pecten quinquecostatus* occurs four times in the Perna-beds and the "Crackers;" reappears higher up, in a diminutive state (associated with some species of Natica, Rostellaria, Trigonia, &c., that occurred in the "Crackers") in a hard grey gritty sandstone between Cliffend and Walpen Chine; again occurs in the upper greensand (at about twenty feet above the gault), in a rather diminutive form, but much improved in appearance since last met with, more than three hundred feet below. For the next fifty feet or so it occurs at intervals in the different beds, and it gradually increases in size until it reaches the chloritic marl, where (as well as in the beds of coarse chalcedony and sandstone immediately below) it attains its maximum size of about two to three inches long, and nearly as much in width. Here its extreme growth is attained. In the next bed, the "fossiliferous marl," it is again diminished, being no more than about half an inch long. It is still smaller in the lower chalk (grey chalk or chalk marl); and as the middle chalk of the locality contains no fossils, it is not met with until we come to the lowermost beds of the upper white chalk, where it is associated with *Spondylus spinosus*, and is in a much more improved condition than when last seen, in the lower chalk.

FOSSIL REMAINS FROM TERTIARY STRATA AT PECKHAM AND DULWICH. —SIR,—Having paid some considerable amount of attention to the works in progress for the Great High Level Sewer, on the south side of the Thames, allow me to offer a few remarks on the fauna and flora discoverable in the series of deposits passed through both in the open cutting at Peckham and the tunnel at Dulwich. No one can doubt their analogy to the Woolwich and Reading series.

First, then, at Peckham I have collected *Paludinæ*, and associated with them what has the appearance of their opercula. The Paludina-band is eight inches in thickness, quite indurated, and about forty-five to fifty feet from the surface. On splitting open these blocks, fine casts of *Unionidæ*, with fish-scales and spines, are exposed, amidst a perfect pavement of *Paludina lenta*. Here and there a remarkable shell occurs, which seems referable to the marine genus *Voluta*; but as true marine beds are in immediate contact both above and below, it may be a derivative fossil. This hypothesis, however, is not borne out by their occurrence in the marine strata, or rather what may be considered estuarine deposits. In these are great numbers of two varieties of oysters, *Ostrea tenera* and *Ostrea edulina*, *Mytilus*, *Cyrena cuneiformis*, *Cerithium*, *Melania inquinata*, *Turritella imbricataria*, and a very beautiful *Arca*, at present undescribed. I must not omit to mention that the oysters have frequently *Calyptrea trocheformis* adhering to them. In your number for February Mr. Evans mentions having discovered the elytron or wing-case of a species of *Dytiscus*. With the most careful scrutiny I have not found any insect-remains as yet; but I met with a portion of fish-scale, which at first sight appears so much like a wing-case, that I was at the moment prepared to indorse Mr. Evans' statement. Traces of lignite close up the Peckham catalogue.

In the Five Fields, Dulwich, a tunnel-shaft introduces us at fifty feet to the plastic clay, charged with the remains of the Lower Eocene flora. I must refer the geological reader to the admirable paper by Mr. Prestwich, published in the Quarterly Journal of the Geological Society, vol. x., 1854, illustrative of his researches in analogous deposits at Reading, and Mr. De la Condamine's, at Counter Hill. The plate which accompanies it figures specimens identical with those collected by myself at Dulwich with one exception. My specimens yield one form not figured by Mr. Prestwich; it looks as if related to *Coniferæ*.

The general reader may be interested to know that leaves of oak, maple, poplar, and willow are abundant, associated with estuarine shells—*Cyrena deperdita* and *C. cuneiformis*; and a new species occur, which I propose to call *Cyrena Dulwichiensis*. In some cases it was possible to take hold of the stem, and lift a portion of the leaf from the clay. How interesting is the thought that in this age we should be able to handle the autumnal leaves, maybe, of forests that flourished during the unreckoned eons of the Lower Tertiary epoch. These leafy remains sometimes form, as it were, a thin blackish carpet over several square feet of clay-surface.

I believe this is the first time that remains of a flora on an extensive scale have been discovered within the metropolitan area of the London basin. Apologising for trespassing so much upon your space, I am, your obedient servant, CHARLES RICKMAN, Hon. Curator Lambeth Museum of Natural History.

P.S. Since writing the above I have seen a mammalian bone, highly charged with iron pyrites, found in a greenish sand, below the leafy deposit; and have myself discovered a ventral scute of the crocodile, associated with drifted wood, bored by teredines.

LETTER FROM MR. SALTER ON MAJOR AUSTIN'S PAPER ON THE SILURIAN ROCKS OF IRELAND, AND ON MR. LEE'S DISCOVERY OF THE PTERASPIS IN

THE LOWER LUDLOW ROCKS.—DEAR SIR,—I see I have been called to account, in more than one page of your February number, for errors of omission and commission; and in acknowledging the paternal rebuke, I am bound to becomea contributor *pro tanto* this month.

First then, with regard to Major Austin's communication, which, in its latter and more important part, gives us a fact of very high interest, viz., the occurrence of man in a true raised beach!

I believe his notice of the small patch of fossiliferous strata on the Waterford coast is quite correct, and that the strata of Newtown Head, opposite his old station at Duncannon, are really of Llandeilo age. But the statement in "Siluria" is also true, viz., that all or nearly all* the Silurians of the south-east portion of Ireland are referable to the Caradoc rocks. It is a wonderfully covered-up country: those who have not ridden across the drift-surfaces which clothe these denuded Silurian tracts can have little idea of the difficulty of getting continuous sections. Hence it is impossible to say with accuracy that we may not find anything or everything Silurian there. But after the best attention that could be given to the whole tract, the government surveyors cannot determine any true equivalents of either the lowest or the succeeding Silurian beds. Prof. Jukes has shown that there are no Lingula flags determinable, and I must be responsible for saying that over the greater portion, at least, of this wide district of Wexford and Waterford there is no proof of anything that can be called Llandeilo-rock, unless it be in the locality under consideration. It is remarkable it should be thus. The Silurian strata are highly contorted, cleaved, and interstratified with abundance of igneous rocks; as much so in parts as the Llandeilo-flag range of Cader Idris, or the wild country round the vale of Ffestiniog. But the Irish traps interstratified with fossil-bearing slates are chiefly of the age of those of Snowdon, and these belong to the overlying series—the Caradoc or Bala rocks, as was shown clearly by Prof. Ramsay in his published sections. Now it so happens that one of the Newtown Heads in Waterford (that near Framore) is an excellent example of the Caradoc strata, and is rather a conspicuous locality for fossils, many of which were published in General Portlock's work. The other Newtown Head, from which Mr. Austin gathered his rare organisms (sent to General, then Lieutenant-colonel Portlock) is immediately opposite Duncannon, but on the Waterford side of the estuary. It is rather a matter of satisfaction to me to find that tne sets of fossils are from distinct localities, for certainly the large species of trilobite, *Oxygia Portlocki* and the others *Ampyx*† and *Acidaspis*, found by Major Austin in his own locality are good Llandeilo types, at least they are such as we may find in other Llandeilo-flag districts, such as Builth, in Radnorshire. But though Caradoc is clearly superposed upon Llandeilo-flags, the difference between the faunas of the two formations is not so great or decided as to enable anyone at a glance to separate them; and there are other districts even in Ireland where perhaps the same distinctions may hereafter be drawn, but of which our knowledge is not perfect enough to enable us to do so at present. All the typical Lower Silurian districts of Ireland, let me say meanwhile, are of the Caradoc or Bala type, not even of Llandeilo age. I allude to the Portrane district near Dublin, the Tyrone, and probably the Fermanagh tracts, and, as before said, by far the greater part of Wexford, if not of Wicklow. In Galway we have middle Silurian rocks; in the picturesque Dingle promontory, the Wenlock and Ludlow beds; and what may be revealed when

* The strata near Waterford are specially excepted as probably of Llandeilo age (p. 185, 2nd edit.). I do not know on what data.

† *Calymene duplicata* is mentioned by Mr. Austin; I have only seen *C. brevicapitata* from the south of Ireland.

the old crystalline schists and quartz-rocks of Donegal are worked out, no man can predicate, probably something much older than all these.

Major Austin's labours, carried on with zealous perseverance long since, well deserve recognition, and we are glad to see him, after years of silence, calling up old memories of hard working days. He was the discoverer of these fossils, though by mistake only alluded to in one or two places in Portlock's great work; and, on different grounds from those on which he founds his opinion, I share it as to the seniority of these particular shales, which appear to be rich in peculiar species, and are worthy further search.

To the other charge of error I might, I think, put in a demurrer, and plead the statute of limitations, for my notice of the new *Pteraspis* was published in the "Annals of Natural History," last July. With every disposition to be just to our kind correspondents, it is sometimes difficult, when geologists work in company, to assign to each person the due credit for their discoveries of new or rare forms. In the present case I need only say that I received the specimen from Mr. Lightbody, the well known geologist of Ludlow, as found at the famous quarry which may almost be said to be the property of the Ludlow geologists, so largely have they worked out its precious contents. The specimen, as I understand, was not only found, but its importance was fully recognized by Mr. Lee, then in company with my friend; and this gentleman, since the publication of my short paper, has most kindly presented the specimen to the Museum in Jermyn Street. I trust he will accept my apology for the inadvertence, which I am certain was not the fault of my friend Mr. Lightbody, but my own.—I am, sir, yours obediently, J. W. SALTER. 18th February.

NOTE ON GOLD-DRIFTS AT BALLAARAT.—DEAR SIR,—Having been for two and a-half years a "wet-digger" in Victoria, I read with much interest the chapter on gold, in the last edition of Sir R. Murchison's "Siluria." As I am not wholly satisfied with all that is therein set forth, perhaps you may deem the few facts I offer sufficiently interesting to merit a place in your valuable periodical.

Mr. Alfred Selwyn, the Colonial Geologist of Victoria, is represented in "Siluria," p. 492, as having "recognized in Victoria gold-bearing superficial drifts of three distinct stages, lying above each other; the lowest or oldest of them containing the remains of wood and seed-vessels, differing little from the present vegetation. That such is the case does not, I believe, hold good of the locality in which I worked, as will be apparent from the following:—

In the beginning of the year 1855, I and others commenced sinking in Spring Gully, Creswick Creek, about midway between Ballaarat and the Clunes quartz-mining-field. About fifteen feet down we came upon a black stratum of drift, about twelve feet thick, composed of very fine mud and sand, with embedded leaves, cones, and blackened wood, very loose and difficult to sink through. Under that we had a stratum, about a foot thick, of reddish clay, with boulders, the "wash-dirt" of the miners, in which the gold was "honey-combed." In driving across the gully the red "wash-dirt" thinned out very rapidly, and disappeared, giving place to the black drift, which here contained boulders and gold: the gold, however, was extremely waterworn, quite different to that obtained in the red drift. Others who sunk nearer the side of the gully had no black drift in sinking, but in driving across the gully invariably struck the black drift, with them presenting the same features as with us. When the gully was abandoned, the dark run of drift might be tolerably correctly followed by the black heaps at the mouths of the old holes, presenting the appearance in its winding of a watercourse having reddish banks.

Nearly a mile off is what was the "black lead," so called from the prevailing colour of the dirt, and running from a southerly direction towards the north. While working in or near the middle of the lead I found nothing contrary to

what Mr. Selwyn has advanced; but the last ground I worked in on that lead being the outermost, or nearest the side of the lead, I again sunk through the black drift, here twenty-five feet thick, containing blackened wood and the cones of the "honeysuckle" *(Banksia)*, and "bottomed" in a stratum of stiff bluish-grey clay, with very large boulders, which stratum was four feet thick. I expect the Spring Gully black drift and the drift of the black lead are of the same age, as the Spring Gully course has been traced to within a short distance of the black lead, which I conceive to have been the main watercourse of that period; indeed, the number of smaller tributary leads of dark colour joining it, in the same way that small streams now fall into larger ones, would indicate that such was the case. Here also the course of dark drift may be easily traced by the black heaps at the surface in striking contrast to the heaps on each side. In following down the black lead we reach Slaughteryard Hill, where the evidence at first may not appear so conclusive, but where, if the facts are carefully weighed, they will I think, be found to support the former.

Standing on the level of the present Cresswick Creek, looking north northwest, Slaughteryard Hill presents a steep escarpment of basalt, which has probably come from the north, as northward the basaltic plateau extends some miles. Southward it does not exceed two hundred yards, thinning out very rapidly. Within one hundred and fifty yards are three leads—the eastern, called the black; the middle, known as the white; and the western lead the red streak—as far as had been determined at the time I left (1857) running parallel; all three running from south to north; all three overflowed by the basalt; and all three above one hundred feet deep; the deepest being the western, *i. e.*, the red streak.

Supposing, for the sake of argument, that the black, which is also the shallowest, is the oldest, we have a period no doubt, judging from the thickness of the deposit (twenty-five feet), extending over a considerable time, characterized, it would appear from the vegetable remains, by extensive and long-continued conflagrations, succeeded by others, in which the utter absence of all igneous appearances prevails, succeeded in turn by an igneous outburst, covering many square miles, with a basaltic overflow. On the other hand, take as the oldest the red streak—the deepest first, the white follows under certain modifications; then, when we reach the period of the black drift, and igneous forces come into operation, it does not call for a great stretch of imagination to suppose that the period was consummated by a grand outburst and overflow of basalt. I am aware that in "Siluria," p. 492, Sir R. Murchison and others account for the charred appearance of the vegetable matter, by showing that such matter is charred and destroyed *in situ* by the basalt; however true that may be in other cases, I venture to think that had those eminent geologists seen the vegetable matter in Spring Gully, where there is no basalt, or other igneous rock, or the evidence that there ever had been such, they would have seen the inapplicability of the reasoning in this instance. The black lead also is black a great way above, that is, much further south than the basalt. In writing the above I do not impugn the accuracy of the observations made by Mr. Selwyn and others, I simply desire to record what I myself observed in the localities I speak of. I never worked elsewhere, and therefore these details are purely local; still, if true, the stratum containing the vegetable matter is not the oldest.—I am, sir, yours truly, W. J. Morgan, Carmarthen.

REVIEWS.

Creation Redemptive; a Contribution to Theological Science. By Rev. S. Lucas, F.G.S. Helston: R. Cunnack. 1858.

Although we rarely, and then but briefly, make any remarks on theological topics in connection with geology, we by no means regard in an unfavourable aspect the numerous treatises and works published with the view to bring into comparison or reconciliation the passages of Holy Writ with the doctrines or teachings of purely physical science. Such attempts are generally in themselves very praiseworthy, both for the incentive that causes them to be produced as well as for the spirit in which most of them are penned. In the unpretentious work, whose title heads these remarks, the order and incidents of Creation are regarded as exhibiting a special design in special relation towards the appearance of the Saviour and the redemption of man.

Pre-adamite Man; or the Story of our Old Planet and its Inhabitants told by Scripture and Science. London: Saunders, Otley, and Co., Conduit-street. 1860.

As we have already said, we are by no means averse to books of a theologico-geological tendency. We know, alas, how much bad theology, and how much bad geology there is in them; but we know, also, and appreciate the motives of the writers, and as such books are usually upon topics in which the mass of mankind take an interest they are likely to be, and indeed are, much read. For our part, be they right or wrong, we like them to be read; for out of the numbers of this class which have been written, there are many, very many, of good quality, whilst of the inferior productions, surely there are but few indeed which do not contain some appreciable amount of geological knowledge; some germs of truth which by these means dispersed, may providentially somewhere take root in favourable soil. Hardly have geologists agreed as to the possible existence of men amongst the mammoths, than the subject is regarded in its theological bearing, and a volume, by no means unpretentious, is placed on our table. The author of "Pre-adamite Man" writes *incog.*; and although personally we do not go the length of his views in respect to a double creation of man—the extinction of a pre-adamite race, and the adding an eighth day to the seven commonly accepted days of creation, we are not by any means disposed to speak unfavourably of his book.

Undoubtedly he falls into some errors in respect to certain former geological phases and changes in the physical condition of our planet; but many of these are popular errors which have been too long favoured even by geologists themselves. Amongst such is one especially requiring contradiction, or at any rate considerable modification and restriction, namely, that granite always forms the basis of the stratified crust of the earth; that it is an igneous rock; that it was originally the first-formed crust, or pellicle of a globe of molten matter. We have already more than once in this magazine, as well as elsewhere, drawn attention to these fallacies. First, then, granite is at most only an eruptive, not an erupted, rock in the sense only that it has sometimes burst, or been forced through the consolidated stratified rocks reposing upon it. In all cases granite has been formed under the dense pressure of a superincumbent mass, and never at the open atmosphere of air or of earth-enveloping vapours, as

would have been the case had it constituted the first disrupted pellicle of a molten globe. In the next place, we do not know that granite always is the foundation-rock of every area. We do not know, moreover, in many, nay most, cases, that it is the lowest rock, for human labour has never penetrated through it, scarcely, indeed, even into it. Thirdly, there is no evidence to prove it is an igneous, *i. e.*, a fire-formed, or molten product. On the contrary, the existence in it of numerous cavities half empty, half filled with water shows that at most hot water or steam has been the active agent of the heat present in its formation. Indeed, to us it appears that granite presents none of the conditions which it should do of a fire-formed, or once fused rock. Its crystalline condition, considering the substances of which it is composed, seems decidedly against that theory, for taking one of its constituents, quartz, for example, will anyone point out a single instance of heat-melted silex that is not vitreous, or glassy after fusion; or a single instance, on the other hand, of a crystalline condition resulting from the action upon that substance of dry heat. Take the felspar, and if you are anything at all of a chemist, will you tell us if the soda, or the potash which it contains is now in the state in which it should be if your granite had ever been fused. All that it is allowable to state of granite is that it is a condition of rock which has been produced at every geological period in the deep-seated regions of the earth immediately below its stratified crust. The truth is, we do not know what is the fundamental rock of the stratified crust of the globe, unless the old gneiss be regarded as such, and with it some of the oldest granites, not all granites indiscriminately.

We should also be inclined to take objection to some of our author's opinions in respect to the physical conditions of the planets, although in others we should be disposed to concur. For example, we should regard the moon as presenting to us a worn-out consolidated globe, not a world in a first or even early stage of condition. If our own globe is presumed to have consolidated from a vaporous state, it must first have passed through a liquid condition; and then the consolidation carried still further, earths and the solid materials would be produced. In the process of time the balance of fluid and gas remaining as sea and atmosphere would be condensed also, and a solid worn-out globe like the moon would appear to be the inevitable result.

The new doctrine attempted to be inculcated by our author's book may be briefly given and best by a few short extracts from the early part (p. 24 *et seq.*).

After describing a period of desolation to which he believes the world, after the destruction of the first human or pre-adamic race, was reduced, and for the warrantry for which state of things he pleads the biblical passage, "and no plant of the field was yet in the earth, and no herb of the field had yet grown, for the Lord God had not caused it to rain upon the earth, and there was not a man to till the ground." Our author continues,

"The new order of things is thus ushered in by a statement of the effects of some great overturn or ruin which had extinguished the existence of the vegetable and animal world, and had snatched from the earth the race of the sixth day men." * * * For "though on the sixth day God created man, male and female, and blessed them, saying, 'Be fruitful, and multiply and replenish the earth, and subdue it,' however fully that blessing may once have been realized, now at least no remains of that race were anywhere to be found, 'for there was not a man to till the ground.' And if all vegetation was thus obliterated, and man extinguished, we conclude that the tribes of the lower animals must also have perished; and that the earth, of whose creation and furnishing we have read in the first chapter of Genesis, was at the period referred to in the opening of this succeeding passage a desolate waste, wherein neither plant nor animal gave token of the creative wisdom and power of God. The dumb rocks alone retained the traces of a brighter era, but the remains

they enclosed pointed to a state of life and motion long passed away, and the baldness of absolute sterility and the silence of the grave brooded over all. * * * What a change is here! The earth erst so green and brilliant is now a wilderness, and man himself, the glory of creation, has been withdrawn from the abodes he occupied on this once blooming world!

* * * * * *

"The ruin is complete indeed, but we must believe it to be only temporary: the world awaits a new development of its Maker's power, and the preliminary movements towards a state of things more excellent than ever are next announced (chap. ii., v. 6, 7), 'There went up a mist from the earth, and watered the whole face of the ground, and the Lord God formed man of the dust of the ground, and breathed into his nostrils the breath of life, and man became a living soul.' There is an entire difference here between the pre-adamite and Adam; the former we have seen starting into being out of nothing, by a word, complete at once in a twofold nature, and invested with power and dominion over all the earth, and all the creatures that inhabit it: blessed by God, with the privilege of spreading abroad his race, and subduing the earth in all its regions to his rule. This second man is in all respects a contrast to the first—in his origin, for he is not created out of nothing, but formed out of the dust of the ground, from which he learns a lesson of humility and dependence. * * * No plants or herbs, no leafy shades, no pleasant fruits at the moment of his birth invited his admiration, or offered him sustenance. And lastly, this contrast is manifested in his state, for he is not yet a king like the pre-adamite. * * * It was not until some time after he had been launched into existence and made to feel his wants—made, perhaps, to cry to God for their supply—that God gave him the happy home he needed * * in that garden eastward in Eden * * not provided by nature, but planted by God himself, having been retrieved by special providence from the ruin that still pervaded the world. * * * In this favoured spot, as he looked he beheld the instantaneous production, or gradual but wondrous development of 'every tree that was pleasant to the eye and good for food, the tree of life also in the midst of the garden, and the tree of knowledge of good and evil.' * * * His lot was to remain where God had placed him; to partake of the bounties provided for him; to keep and dress the garden in which he had found so pleasant a home; and to praise and glorify the God who made him. * * * His predecessor had all the world for his possession; Adam neither enjoyed nor coveted the same wide empire. * * * His food was bestowed by special grant. * * * He was not permitted to be idle, for the duty was imposed on him of keeping and dressing his little territory (v. 15). Nay, more, even this restrained freedom was still further limited, for even from among the trees within his reach was one special reservation made. * * * May we surmise that the earliest type of man had abused his freedom, and that the Creator saw good to withhold from his successor the risk of a proud inflation and a self dependence which had proved too much for him."

To this follows the creation of Eve. "The six days' creation had brought into the world a vast, but already extinct, array of animals; * * but in this new creation most of these types were * repeated in the new formed species, generally of smaller and finer mould." The present animal creation, then, the author regards as distinct from the previous one. And of Eve he continues: "The female of the sixth day had been made by the same divine process as the male. They were both 'created;' * * but here in a very special manner the woman drew her being from what had already been formed. She was not modelled from the dust like Adam, but derived both her body and her life from him. 'And the rib, which the Lord God had taken from the man made he woman, and brought her unto the man.' * * * Her introduction to the

world was not like Adam's, amid the rugged ruins of an ancient empire. * * She had not seen Eden planted or peopled by the Creator for her; but when Eve opened her eyes to the light of day, it was among the bowers of Paradise. * * * And while it was the first grand lesson of God to Adam that he should rely on Himself directly and solely, to Eve he pointed out an earthly head, under Himself, * * in whom she might repose her confidence, * * and apply in her necessities; at once her guardian, her teacher, her provider, and her husband."

As a discussive, although extremely speculative, book on a now popular and interesting subject, "Pre-Adamite Man" is worthy of perusal, although we do not apprehend it will make many converts to the novel doctrines it inculcates.

Archaia; or Studies of the Cosmogony and Natural History of the Hebrew Scriptures. By J. W. Dawson, L.L.D., F.G.S.

Of all the books of geologico-theological aspects which have appeared this season, or indeed for many seasons past, "Archaia," by Dr. Dawson, is the best. In it he has given us the result of not only a series of exegetical studies of the first chapter of Genesis, but also lucid observations on the numerous incidental references to nature and creation in other parts of the bible; the entire work being a really useful digest of the cosmical doctrines of the Hebrew scriptures.

In the introductory remarks very beautiful allusion is made to that remarkable serf-population that more than thirty centuries ago emancipated itself from Egyptian bondage, and after years of wandering desert-life, settled itself on the hills and in the valleys of Palestine, and whose migration is the most remarkable in the annals of the world's history, not merely in its political, but in its moral results. Those slaves thus liberated were no mean herd, but were aspirated by a noble spirit and high hopes, and guided by a man of remarkable perception and intellect, the great Hebrew law-giver, who has woven into his grand historical and political composition a wonderful cosmogony, in which the act of creation is simply but most grandly assigned to the One Deity—the Creator and Preserver, and Lord of Hosts. It is this committal of itself to certain cosmical doctrines and statements that has given rise to the collisions into which science and scripture have been brought.

The difficulties and intricacies of the case have been boldly and firmly, at the same time honestly and honourably, looked into by Dr. Dawson; and although we are far from agreeing with him on all points, we advise the perusal of his remarks by all who are really interested in the identification of the sublime views of the biblical account of creation with the also sublime deductions of science.

That our readers may see the value of the work, we give them the sequence of the topics discussed. Beginning with the objects, character, and authority of the Hebrew cosmogony, we are passed on to the general views of nature contained in the Holy Scriptures, then to those remarkable incidents—the beginning, the desolate void, light, the days of creation, the atmosphere, the dry land, the first vegetation, the heavenly luminaries, the lower and the higher animals, man, and the resting of the Creator. Then follows a disquisition on the unity and antiquity of man; and the work is terminated by a chapter of comparisons and conclusions, boldly drawn and as boldly spoken in an honest but fearless spirit.

These conclusions of Dr. Dawson are thus summed up: "In the natural as well as in the moral world the only law of progress is the will and the power of

God. In one sense, however, progress in the organic world has been dependent on, though not caused by, progress in the inorganic. We see in geology many grounds for believing that each new tribe of animals or plants was introduced just as the earth became fitted for it; and even in the present world we see that regions composed of the more ancient rocks, and not modified by subsequent disturbances, present few of the means of support for men and the higher animals; while those districts in which various revolutions of the earth have accumulated fertile soils or deposited useful minerals are the chief seats of civilization and population. In like manner we know that those regions which the bible informs us were the cradle of the human race, and the seats of the oldest nations, are geologically among the most recent parts of the existing continents, and were no doubt selected by the Creator partly on that account for the birthplace of man. We thus find that the bible and the geologists are agreed not only as to the fact and order of progress, but also as to its manner and use.

"Both records agree in affirming that since the beginning there has been but one great system of nature. We can imagine it to have been otherwise. Our existing nature might have been preceded by a state of things having no connection with it. The arrangement of the earth's surface might have been altogether different. Races of creatures might have existed having no affinity with or resemblance to those of the present world; and we might have been able to trace no present beneficial consequences as flowing from these past states of our planet. Had geology made such revelations as these, the consequences in relation to natural theology and the credibility of scripture would have been momentous. * * * The questions would naturally have arisen, Are there more creative powers than one? If one, is he an imperfect or capricious being, who changes his plans of operation? * * * Happily for us, there is nothing of this kind in the geological history of the earth, as there is manifestly nothing of it in that which is revealed in scripture. In the scripture narrative each act of creation prepares for another, and in its consequences extends to them all. The inspired writer announces the introduction of each new part of creation, and there leaves it without any reference to the various phases which it assumed as the work advanced. In the general view which he takes, the land and sea first made represent those of all the following periods. So do the first plants, the first invertebrate animals, the first fishes, reptiles, birds, and mammals. He thus assures us that, however long the periods represented by days of creation, the system of nature was one from the beginning. In like manner, in the geological record, each of the successive conditions of the earth is related to those which precede and to those which follow, as part of a series. So also a uniform plan of construction pervades organic nature, and uniform laws the inorganic world in all periods.

"We can thus include in one system of natural history all animals and plants, fossil as well as recent; and can resolve all inorganic changes into the operation of existing laws. The former of these facts is in its nature so remarkable, as almost to warrant the belief of special design. * * * The periods into which geology divides the history of the earth are different from those of scripture; yet, when properly understood, there is a marked correspondence. Geology refers only to the fifth and sixth days of creation, or at most to these with parts of the fourth and seventh; and the only natural division that scripture teaches us to look for are those between the fifth and sixth days, and those which within these days mark the introduction of new animal forms, as for instance the great reptiles of the fifth day. We have already seen that the beginning of the fifth day can be referred almost with certainty to that of the Paleozoic period. The beginning of the sixth day may with nearly equal certainty be referred to that of the Tertiary era. The introduction of great

reptiles and birds in the fifth day, synchronizes and corresponds with the beginning of the Mesozoic period; and that of man at the close of the sixth day, with the commencement of the modern era in geology. These four great coincidents are so much more than we could have expected in records so very different in their nature and origin that we need not pause to search for others of a more obscure character. * * * In both records the ocean gives birth to the first dry land, and it is the sea that is first inhabited, yet both lead at least to the suspicion that a state of igneous fluidity preceded the primitive universal ocean. In scripture the original prevalence of the ocean is distinctly stated, and all geologists are agreed that in the early fossiliferous periods the sea must have prevailed much more extensively than at present. Scripture also expressly states that the waters were the birth-place of the earliest animals; and geology has as yet discovered in the whole Silurian series no terrestrial animal, though marine creatures are extremely abundant; and though air-breathing creatures are found in the later Paleozoic, they are, with the exception of insects, of that semi-amphibious character which is proper to alluvial flats and the deltas of rivers. * * * Both records concur in maintaining what is usually termed the doctrine of existing causes in geology. Scripture and geology alike show that since the beginning to the fifth day, or Paleozoic period, the inorganic world has continued under the dominion of the same causes that now regulate its changes and processes. The sacred narrative gives no hint of any creative interposition in this department, after the fourth day; and geology assures us that all the rocks with which it is acquainted have been produced by the same causes that are now throwing down detritus in the bottom of the waters, or bringing up volcanic products from the interior of the earth. * * * Lastly, both records represent man as the last of God's works, and the culminating point of the whole creation. * * * Man is the capital of the column, and if marred and defaced by moral evil, the symmetry of the whole is to be restored not by rejecting him altogether, like the extinct species of ancient times, and replacing him by another, but by recasting him in the image of his Divine Redeemer. Man, though recently introduced, is to exist eternally. He is in one or another state of being to be the witness of all future changes of the earth. He has the option before him of being one with his Maker, and sharing in a future glorious and finally renovated condition of our planet, or of sinking into endless degradation."

First Traces of Life on the Earth. By S. J. Mackie, F.G.S. London: Groombridge and Sons. 1860.

This little book, designed to display as a simple but highly instructive geological lesson the first appearance of animated beings on our planet, as indicated by the oldest fossils yet discovered, is now issued.

Emanating as it does from the pen and pencil of the editor of this magazine, it would be obviously out of place to review it here. We therefore content ourselves with expressing the hope that it may be favourably received by the public; and that, in turning the thoughts of its readers towards this one eventful passage of the past history of our planet, it may become the medium, by directing their minds to the study of the beneficent designs of the Eternal in past ages, to the just comprehension of the aim and purpose of the great creative scheme in which we are all acting our parts.

THE GEOLOGIST.

MAY, 1860.

ON CANADIAN CAVERNS.

By George D. Gibb, M.D., M.A., F.G.S., Member of the Canadian Institute.

(*Continued from page* 133).

1.—Caverns on the Shores of the Magdalen Islands.

On passing the interesting group of islands in the Gulf of St. Lawrence, known as the Magdalens, the observer is struck with their beautiful and picturesque appearance, which is suddenly presented to his view. The cliffs, which vary in height, present equally various colours, in which the shades of red predominate; these, contrasted with the yellow of the sand-bars, and the green pastures of the hill-sides, the darker green of the spruce trees, and the blue of sea and sky, produce an effect, as Captain Bayfield describes, extremely beautiful, and one which distinguishes these islands from anything else in the Gulf. Such an agreeable picture it has been my own good fortune to witness and admire. The striking feature in their formation is the dome-shaped hills rising in the centre of the group, and attaining a height of from two hundred to five hundred and eighty feet. They are composed of the Triassic or New Red Sandstone formation, which forms their base, being surmounted or topped by masses of trap rocks. The highest of the Magdalens is Entry Island, with an elevation of five hundred and eighty feet; its red cliffs rise at its north-east point to three hundred and fifty feet, and are what they have been described, truly magnificent and beautiful. The soft and friable character of the brick-red cliffs forming the shores of these islands, with their remarkable capes and headlands, have in many places yielded to the force of the waves, and have become worn into arches and caverns. This is more strikingly manifest at Bryon Island, which is nearly surrounded by perpendicular or overhanging cliffs, which are broken into holes and caverns, and fast

giving way to the action of the waves. From the same cause are to be seen detached peninsular masses in a tottering state, which now and then assume grotesque forms. There is something peculiarly interesting in this singular group of islands, lying so isolated about the centre of the great Gulf of St. Lawrence; and curiosity would be well repaid by a visit from one of the neighbouring ports. (See outline of Bryon Island, plate v.).

2.—Caverns and Arched Rocks at Perce, Gaspe.

On the eastern coast of Gaspe, in the Gulf of St. Lawrence, there is a range of limestone cliffs, which commence on the south-west side of Mal Bay, at the perforated rock, called Ile Percé, and thence run in a north-north-west direction. Immediately south of these cliffs, which are six hundred and sixty-six feet in perpendicular height above the level of the sea, as described by Bayfield, are the Percé mountains, the highest of which, Mount Percé, is twelve thousand and thirty feet, and is visible forty miles out to sea.

The town of "Ile Perce," as it was called in Charlevoix's time, occupies the shores of Percé Bay, running from Point Percé to White Head. This writer mentions in the second volume of his "Histoire de la Nouvelle France," p. 71, that Sir William Phipps, in his expedition against Quebec, landed at Ile Percé, in Sept., 1690, pillaged the town and robbed the church.

A reef connects the Percé Rock with Point Percé. This remarkable perforated rocky islet, which gives the name of Percé to this locality, is two hundred and ninety-nine feet in height, precipitous all round, and bold to seaward. This islet and the island of Bonaventure are considered outliers of the conglomerate rocks which enter into the formation of the main land at Percé, the former would seem especially to be a continuation of the range of cliffs on the south-west side of Mal Bay.* The Split Rock is an almost inaccessible mass of this strata, and stands up like a mall, in continuation of the limestone-cliffs of Barry Cape (Point Percé). It is five hundred yards long, one hundred broad, and is remarkable for the presence at its western half of two large holes or arches, through one of which a sloop at full sail can pass at high water. There is a lateral arch at the north-east side, scarcely perceptible from the water.

The perforations in this rock have been formed by the action of the waves of the sea, the same cause which has in the progress of time effected the disjunction of these outliers from one another and the main land. From the present position of the islet, which lies

* Both islands are composed of the great mass of conglomerate, belonging to the lower carboniferous series, which here caps the Devonian rocks, and is made up of pebbles of all the rocks, from the old Laurentian of the north shore of the Gulf of St. Lawrence to the Devonian.—Professor Dawson's "Week in Gaspe." Canad. Nat. and Geol. Oct., 1858.

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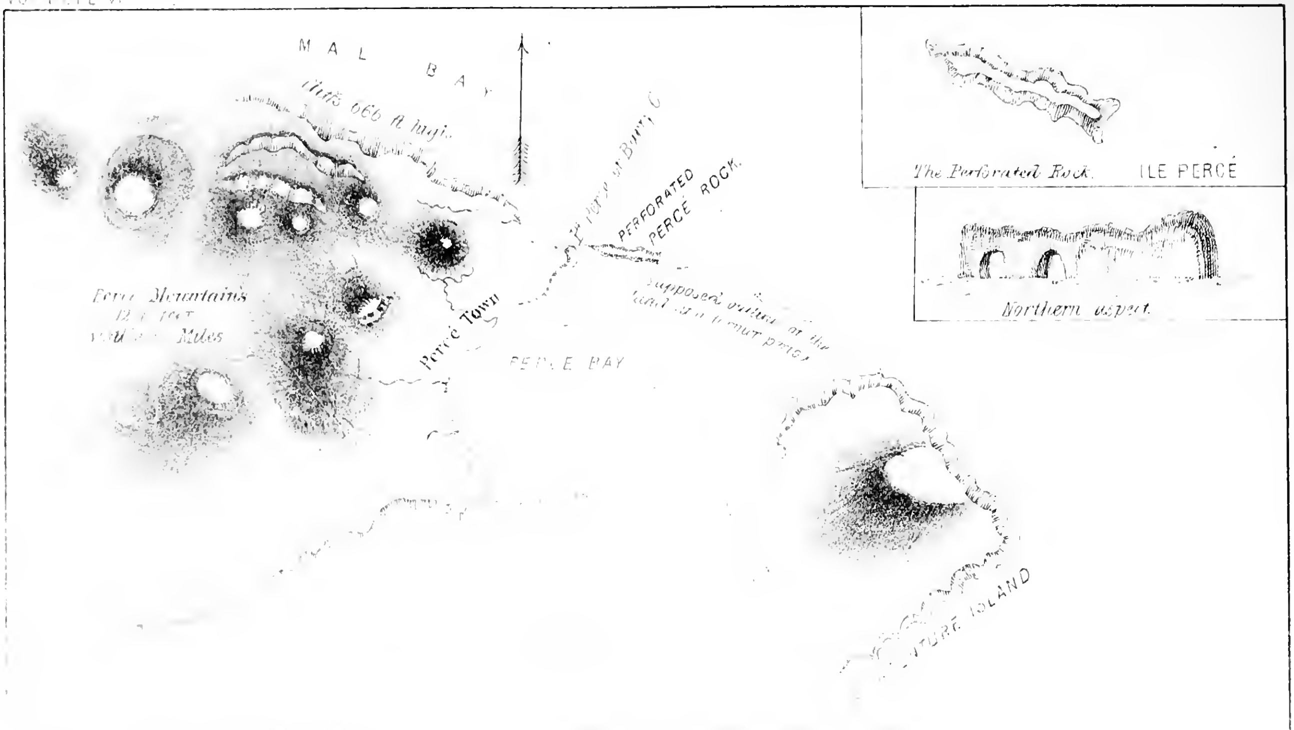


MAL BAY
Cliffs 666 ft high.
PERFORATED
PERCE ROCK.
Perce Town
Perce Mountains
Miles
PERCE BAY
ISLAND
The Perforated Rock.
ILE PERCÉ
Northern aspect.

almost north and south, I am disposed to consider its northern aspect as the oldest, the two arched openings at that side forming what were once the entrance to deep caverns running into the rock southwards, which in the course probably of ages has been washed away by aqueous denudation. This view is strengthened by an examination of the intervening shores as they exist at present, which are portrayed in the diagram (plate vi.). It will be perceived that the coast line of Ile Perce runs along to Bonaventure Island, with an imaginary position of the land at one time between the south-west part of the latter island and the shore at the Bay of Perce, at the point where the cliffs commence at its southern third. This gives the southern coast a semicircular course, with a low shelving beach corresponding to that which now exists at Percé Bay on the one side, and the western coast of Bonaventure on the other; whilst the northern coast is rocky and precipitous, probably pierced with many caverns, and gradually diminishing in height to the southward.

3.—Gothic Arched Recesses at Gaspe Bay.

The south-western shore of Gaspe Bay—from Point Peter to Douglass Town, a distance of twelve miles—consists of a succession of precipitous headlands, which in some places are two hundred feet above the sea. Going southward from Seal Cove, a part of the cliffs is composed of greenish-grey or drab-coloured pebbly sandstone, with many beds of conglomerate. In these beds dark red shale-balls exist, which yield to the weather and the beating of the sea, and leave large holes in the cliffs. The conglomerate beds, which belong to the Portage and Chemung groups of the Devonian or old red sandstone formation, are described as harder and more resistant to these influences and the irregularity in the wear of the rock, of which the dip is at an angle of sixty degrees, produces recesses and arches, giving the precipice the appearance of a piece of Gothic architecture.* From Point Peter the land rises in undulations to the chain of mountains, which lie about five miles in land. They attain to an elevation of fifteen hundred feet, and sweeping round Mal Bay, terminate with the Percé mountains, previously mentioned.

4.—The "Old Woman," at Cape Gaspe.

If a line is drawn in a north-north-east direction across Gaspe Bay from Seal Cove, it will touch a remarkable headland, or finger-shaped promontory of Gaspe limestone, called Cape Gaspe, which is the termination of a magnificent range of cliffs, six hundred and ninety-two feet above the sea. Close to the south-east extremity of the Cape was the "Old Woman," or Flower Pot Rock, sometimes called "Ship's Head" by the fishermen, and formed in a similar manner to the Flower Pot Rocks of the Mingan Islands. It was a

* Geol. Survey of Canada. Report of Progress for 1844.

truly remarkable object, and described by Captain Bayfield as being worn so small at its base by the waves, that it appeared astonishing that it could resist their force or the pressure of the ice. It subsequently disappeared, and has fallen into deep water, it base having become worn away by the action of the sea; but for a long time it formed a prominent object to the mariner. Boats could pass between it and the Cape when there was no surf. The Gaspe limestone of the Cape is the equivalent of the Niagara limestone of the upper Silurian formation. (See map, plate vi.).

5.—Little River Caverns, Bay of Chaleur.

From Cape D'Espair to Little River, in the Bay of Chaleur, the cliffs which form the coasts are composed of beds of conglomerate, which belong to the lower carboniferous rocks already mentioned, with a gentle dip to the southward. They have been described by Sir Wm. Logan as very narrow, and consisting of nothing more than mere patches of the rim of the formation. These have been saved from the wearing action of the sea, which has carried off other parts, by the presence of harder tilted strata at high-water mark. This is well seen at the present time, for wherever the cliff is wholly formed of the rough conglomerate, deep horizontal caverns have been formed beneath by the action of the waves dashing against their base. The cliff being thus deprived of support, great masses, cracked vertically off fall in huge fragments, which form a temporary talus, of which Sir William believes that it is possible the ice of winter may assist other causes in effecting a removal.*

6.—Arched and Flower Pot Rocks of the Mingan Islands.

The Mingan Islands are twenty-nine in number and uninhabited, they lie close to the northern shore of the Gulf of St. Lawrence, are bold and precipitous on their north, east, and west sides, whilst they are low and shelving towards the south. None of them exceed three hundred feet in height, and ancient beaches and terraces are met with in nearly all, far above the reach of the highest tides. The present appearances of these islands are such as to indicate that at one time probably hundreds of caverns existed at the base of the cliffs and precipices of the Lower Silurian limestone rocks which were exposed to the wearing action of the sea. The violent action of the waves must have been nearly as great at one time as at present subsists on the shores of the Shetland Islands, where huge caverns are worn out of the hardest and most ancient rocks, which at the same time offer a greater resistance than the soft limestones which compose the Lower Silurian formation. The evidences of former sea-caverns in the Mingans consist of many hundreds of columns of various shapes and heights resembling flower-pots, and arched and

* Geol. Survey of Canada. Report for 1844.

[illegible] ISLAND
THE MAGDALENS

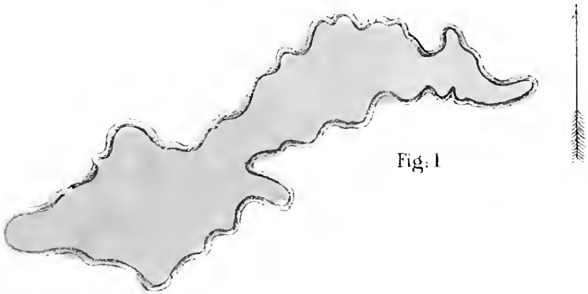


Fig: 1

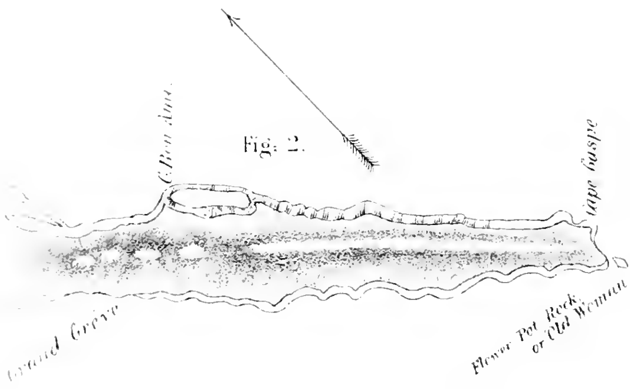


Fig: 2.

THE "OLD WOMAN" CAPE GASPE

perforated rocks. Although frequently seen by mariners and others, the only account published of them is in a paper by Captain (now Rear-Admiral) Bayfield, in the fifth volume of the Transactions of the Geological Society, second series, wherein a plate is given of a number of natural columns on the east coast of Niapisca Island.

These curious columns are met with in most of the islands far above the reach of the highest tides, running along the ancient raised beaches. A picturesque group is found on the west side of Large Island, a mile to the northward of its south-west point. Here hundreds of flower-pot and arched rocks stand up out of the rising tide to heights varying from ten to fifteen feet on the flat limestone, with breadths from a few feet to thirty or forty, widening at the top. Many again are above high water mark; and many straggling flower-pots are seen high up in the island, and with the succession of raised terraces strikingly illustrate the relative levels of the sea and land, when from fifty to sixty feet different to what they are at present.* A remarkable flower-pot rock is to be seen on the south-west point of the Outer Birch Island.

According to Admiral Bayfield, most of them vary in height from fifteen to thirty feet; some even exceed forty feet above the plateau of rock on which they stand. They are frequently arranged in lines upon terraces of limestone, precisely similar to those which are at present forming out of cliffs that are washed by the waves. This is especially the case at the eastern end of Niapisca Island, where the largest and most remarkable group of these rocks is to be seen.

It seems to me that there cannot be any doubt as to the manner in which these curious natural objects have been formed, namely, from the effect of the waves at different levels, as we see the same process going on at the present day. Great or small holes are broken by the sea into the limestone cliffs; these become larger and larger, spreading in various directions, when the roof of the caverns gives way, and leaves one or several pillars with a small base to support a partially arched top. The angular irregularities of the upper part of the pillar become worn away by the action of the sea and of the elements, as the land slowly rises, and we have what certainly resemble flower-pots, towers, and incomplete arches situated high up above the influence of the tides, and formed as it were of horizontal layers of limestone piled one above the other.

A section of Large Island was found by Mr. Richardson of the Canadian Geological Survey, to be composed of limestones of the Chazy, Bird's-eye, and Black-river formations, exceedingly favourable to the wear of the sea into arches and perforations. Most of the other islands are formed in the same strata, the most northerly, however—Harbour Island, consisting of the calciferous sand rock, which lies immediately above the Potsdam sandstone; whilst the main land is composed of gneiss belonging to the Laurentian system.

* Geol. Survey of Canada. Report for 1856.

7.—Pillar Sandstones, North Coast of Gaspe,

There is a small fishing station below St. Anne, on the North West Coast of Gaspe in the River St. Lawrence, which is called Tourette, from the occurrence of two pillars in the rocks of the coast formed by the action of the sea. The deposits in this vicinity consist of sandstones associated with bands of red and black argillaceous slates which belong to the Sillery group of the Middle Silurian formation. From atmospheric influences, the rock as described by Sir. Wm. Logan* becomes fretted and pitted by deep holes or cells of various sizes and shapes, with thin but well marked divisions between them. The stone is soft, and appears to wear fast; and when the strata are vertical, or nearly so, the action of the sea between high and low water marks cuts them into pillars thirty feet in height, and four or five across, which, being sometimes smaller at the base than the summit, produce a very picturesque effect in the surrounding landscape. These pillar sandstones, as they are called, occupy the greater part of the coast between Cape Chat and the small settlement of Little Matan, where they disappear. Mr. Murray mentions† that they are displayed in considerable thickness near Little Metis, and occupy the coast as far as the Great Metis River, when red and green shales appear, which occupy the coast as far as Rimouski. This rock has the same tendency to wear away into pillar like shapes, when the strata are highly inclined, and the same kind of cellular fretted surfaces are observed to occur here as at Turettes and Cape Chat. Somewhat similar natural objects are seen on the south shore of New Brunswick, on proceeding from Dipper Harbour towards St. John, in the form of deep chasms and hollows, often separated from each other by large grotesque columns. The carboniferous limestone rocks here being of unequal hardness, yield to the sea at one point, and resist it at others; hence the rudest figures and most unsightly pinnacles are placed according to the taste of the most disordered imagination.

8.—Niagara Caverns.

Of the four spots in the immediate vicinity of the Niagara Falls which receive the name of caves, but one only is present on Canadian territory, situated a mile and a half below the falls, half way between Clifton House and the suspension bridge. It was at one time called the Devil's Hole, but is now known as Bender's Cave, and is a natural excavation in the finely granular magnesian limestone, full of geodes lined with pearl spar, which here belongs to the Niagara limestone formation, hence sometimes called geodiferous limestone. A ledge of rock, twelve feet below the summit of the

* Geological Survey of Canada, Report for 1844.
† Geological Survey of Canada, Report for 1845-6.

precipice forms the floor of the cave, which is entered by a large mouth, is six feet high and twenty feet square; the roof is uneven and covered with damp mould.

There is another cave in the same formation, on the opposite, or American side of the gorge, about sixty rods above the ferry, very difficult of access from the steep and precipitous nature of the banks. It goes by the name of Catlin's cave, is fifteen feet wide and ten high, and contains specimens of silicified moss. Neither of these caves are looked upon as objects of interest, their formation I conceive to have taken place at the time when the banks in which they exist were overflowed by the falls.

The appellation of the Devil's Hole is now given to a notch or indentation, said to be a hundred and eighty-five feet deep, half a mile below the whirlpool, on the right or eastern side of the Niagara river. It lays but a few feet from the main road, and can be looked into from above; it cuts through the Niagara limestone and shale, and Medina sandstone. This has been magnified into a great chasm, surmounted by projecting cliffs of rock, but it is not strictly entitled to the name of a cavern.

There is a great hollow at the foot of the rock, between Goat and Luna Islands, formed by the disintegrating action of the water on the soft Niagara shale forming this part of the precipice, the crumbling fragments of which have been washed away, leaving the true Niagara limestone rock arching overhead fully thirty feet beyond the base, in a similar manner to Table Rock and its continuation under the falls, which thus permits of visitors passing behind the great sheet of falling water in both places. This great hollow, known as Cave of the Winds, whose base is a hundred and thirty feet from the projecting ledge above, is a hundred feet wide. Those who have visited this interesting spot will, in common with myself, no doubt remember the sheet of falling water in front, forming a transparent curtain, dashing the spray with considerable force over every part of the cave, and the appearance of one or more arcs of a rainbow when the sun is shining upon it. The noise and turmoil of the place, the concussion of the atmosphere, and the general disturbance around, have appropriately given rise to the name which this cavern enjoys.

9.—Flower Pot Island, Lake Huron.

The Isle of Coves is situated to the north of Cape Hurd, which is the extreme point of the peninsula of the Indian Reserves in Lake Huron. To the east of this island is Flower Pot Island, which is chiefly remarkable for the presence of a number of insulated columns resembling flower pots, consisting of large tabular masses placed horizontally one upon the other, being broad at the summit and narrow below. The largest of these is forty-seven feet high, and resembles a jelly-glass, being worn small near its base, and enlarging symmetrically towards the top. Many of them stand on a floor of

rock (composed of the Niagara limestone), which projects into the lake from the lofty island which bears their name. On other parts of the coast the rock is still wearing away by the action of the waves into the same remarkable pillar-like shapes. Those which at present exist have been formed in a similar manner to the Flower Pots on the Mergan Islands, and the "Old Woman" of Gaspe, having at one time constituted caverns, as I have already described.

10.—Perforations and Caverns of Michilimacinac Island, Lake Huron.

The Island of Michilimacinac is situated near the straits of the same name, at the north-western part of Lake Huron, and is composed of gypsiferous limestone and rocks belonging to the Onondaga salt group of the American geologists. It is a hundred and fifty feet in height, and its precipitous cliffs are broken into a number of shallow and deep caverns by the action of the waves. One of these perforates a projecting point of rock near its south-east angle, and the general appearance of the coast is not dissimilar to that of the Pictured Rocks, presently to be described, only that they are not on such an extensive and grand scale. Besides these caverns, produced by aqueous agency, three objects of natural curiosity, are visited by strangers in this island—they are the Giant's Arch, the Natural Pyramid, or Sugar Loaf Rock, and the Skull Rock. The last of these is noted for the presence of a cavern, which would appear at one time to have been a place of ancient Indian sepulture, as numbers of human bones were discovered within it, and are even now observed laying about its mouth. The entrance to the cavern is low and narrow, but its dimensions are not very considerable. It possesses some historical interest for Canadians, from the fact that it was in this cavern that Alex. Henry was secreted by a friendly Indian after the massacre of the British garrison at Old Michilimacinac, in 1763.*

11.—The Pictured Rocks, Lake Superior.

These are included in the present paper, although in the territory of the United States, because they were celebrated among the French Voyageurs, who gave them the name of Les Portailles. The Pictured Rocks (as they are now best known) continue for twelve miles along the south coast of Lake Superior, about eighty miles west of White Fish Point. They consist of a series of lofty cliffs, varing in height, but mostly of three hundred feet, and are composed of horizontal stratified layers of grey sandstone, weathering of different tints, which are the equivalent of the Potsdam sandstone, a white quartz rock, probably overlaid here in some places by the calciferous sandstone. All along this coast the fury of the waves,

* See Henry's Travels and Adventures.

increased by every north wind, has produced a wearing action upon the base of the cliffs, scooping out arches and caverns, with overhanging precipices, towering walls, diversified by waterfalls, numerous bays and indentations. Among the five great lakes, there is no spot so sublimely picturesque as the Pictured Rocks, which have been eloquently noticed by Schoolcraft. For miles all these wonderful natural effects are seen by the traveller, their character constantly varying as the destructive elements at work throw down the overhanging strata in terrible ruins by the cavernous destruction of their base. At a distance these rocks are said to resemble delapidated battlements and desolate towers. In many places the cliffs are nearly separated from the main land by extensive fissures, or they are almost solely supported by rude pillars, which form the divisions between numerous caverns, extensive enough to allow of boats to sail through them. At the Daric Rock, near the commencement of the pillared precipices, a vast entablature rests on two immense rude pillars, which formed the boundaries of one or more caverns. The action of the waves has completely excavated the rock at La Portail, which permits at this point a series of heavy strata of sandstone to rest solely on a single pillar standing in the lake, and is slowly becoming disintegrated by the same destructive action.

Schoolcraft thus expresses his admiration of the Pictured Rocks: "All that we read of the natural physiognomy of the Hebrides, of Staffa, the Doreholm, and the romantic isles of the Sicilian coast, is forcibly recalled on viewing this scene; and it may be doubted whether, in the whole range of American scenery, there is to be found such an interesting assemblage of grand, picturesque, and pleasing objects."

12.—Saint Ignatius Caverns, Lake Superior.

The sandstone precipices of the island of St. Ignatius are described as not running down to the water's edge. On some of the islands, however, to the eastward, these cliffs reach the water, with fretted, crumbling fronts, and the parts accessible to the waves are often scooped into small caverns, supported on low arches like those in Grand Island, on the south shore of Lake Superior, but on a much smaller scale.*

13.—Pilasters of Mammelles, Lake Superior.

There is a singular rock, named La Grange, upon the south end of a low island, sixteen miles, S.W., from Grand Point, which rises at once perpendicularly for about ninety feet, rent at the top into rude battlements, and marked along its mural sides by deep pilasters.

* Geography and Geology of Lake Superior, by Dr. Bigsby, Tran. Geol. Soc., ser. 2, vol. i.

It is a conspicuous object for a great distance, and resembles a tower in ruins.*

14.—Thunder Mountain and Pate Island Pilasters, Lake Superior.

Thunder Mountain, several miles long, rises from the eastern angle of Thunder Bay, and is fourteen hundred feet high as measured by Count Adriani. The west half of its summit is almost tabular; whilst the eastern half is irregular and hummocky, dipping suddenly in round masses, into a lower but still elevated country. About the middle of its south side, where the height is greatest, an immense cavity, with steep woody acclivities, is scooped out of the body of the mountain. The upper third of the elevation in the south-west is occupied by precipices, fissured into vertical pilasters, weathering orange red, and occasionally advancing in the form of large buttresses. These precipices are very extensive. The pilasters are smooth prolonged perpendicular slabs, formed by the disappearance of vertical slips of rock, at certain intervals.†

The tower-like eminence, fourteen hundred feet in perpendicular height at the west end of Paté Island, some miles distant, is flat-topped, and its sides are faced with vertical pilasters resting on a talus, like those of the Thunder Mountain. These pilasters have been compared to basaltic columns in the distance, with an apparent but not real horizontal stratification. "In some places they have fallen out, leaving hollows like flues in the side of the cliff. In other places single columns stand out alone, like chimneys; in others again, huge flat tables of rock have scaled off from the face of the wall."‡ Trappose greenstone is the prevailing rock from Thunder Mountain westward, and gives rise to the pilastered precipices of Fort William.

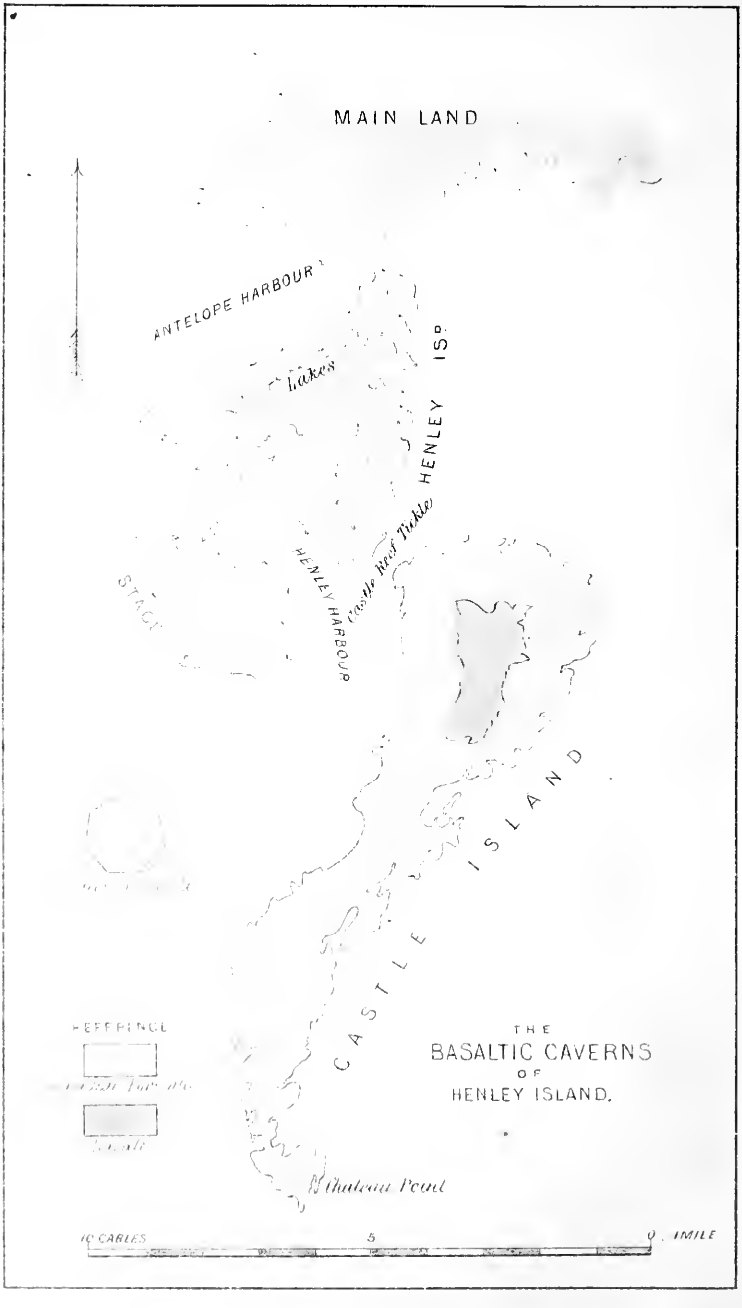
All the foregoing (Nos. 12, 13, and 14) are formed by the rocks belonging to the Huronian system of Sir William Logan, which consist of slates, sandstones, limestones, and conglomerates, with immense masses of greenstone interstratified. These repose unconformably upon the Laurentian rocks. The Grange is composed of greenstone, as well as many of the low islands of the Mammelles and others, which have become hallowed by the waves into bowls, caves, and small arches. Many of the rude colonnades are formed of porphyry, which plunge into the lake, or crown the highest summits, and occasionally they are fissured. The pallisades of Thunder Mountain are a greenstone trap.

In describing the geological structure of Maimanse, the most eastern promontory on the shores of Lake Superior, Dr. Dawson of

* Geography and Geology of Lake Superior, by Dr. Bigsby, Tran. Geol. Soc., ser. 2, vol. i.

† Idem.

‡ Agassiz, Lake Superior, p. 93.



THE
BASALTIC CAVERNS
OF
HENLEY ISLAND.

Montreal, mentions that the shore for some distance is excavated into many small caverns and ravines by the waves acting on the tufa and mineral veins. Some of these excavations are stated to be at a higher level than that of the waters of the Lake at the present time.*

15.—The Steinhauer Cavern.

The mountains of Torngarsuit, or the Evil Spirit, which are situated in latitude sixty degrees immediately south of Cape Chudleigh, the extreme northern point of the eastern coast of Labrador, have been described as rugged, barren, and black, and containing a huge cavern which the Eskimos declare to be the habitation of the devil. The only reference to this cavern which has come under my notice is that by the Rev. Mr. Steinhauer, whose notes on the geology of the Labrador coast are published in the second volume of the Transactions of the Geological Society (p. 488). However little is known about it in relation to its extent and the formation in which it exists, which is most probably Laurentian from the description of the rocks on the east coast of Labrador, it seems appropriate to call it after the name of him who first drew attention to it. This cavern is most likely developed in the crystalline limestone belonging to the Laurentian rocks.

16.—The Basaltic Caverns of Henley Island.

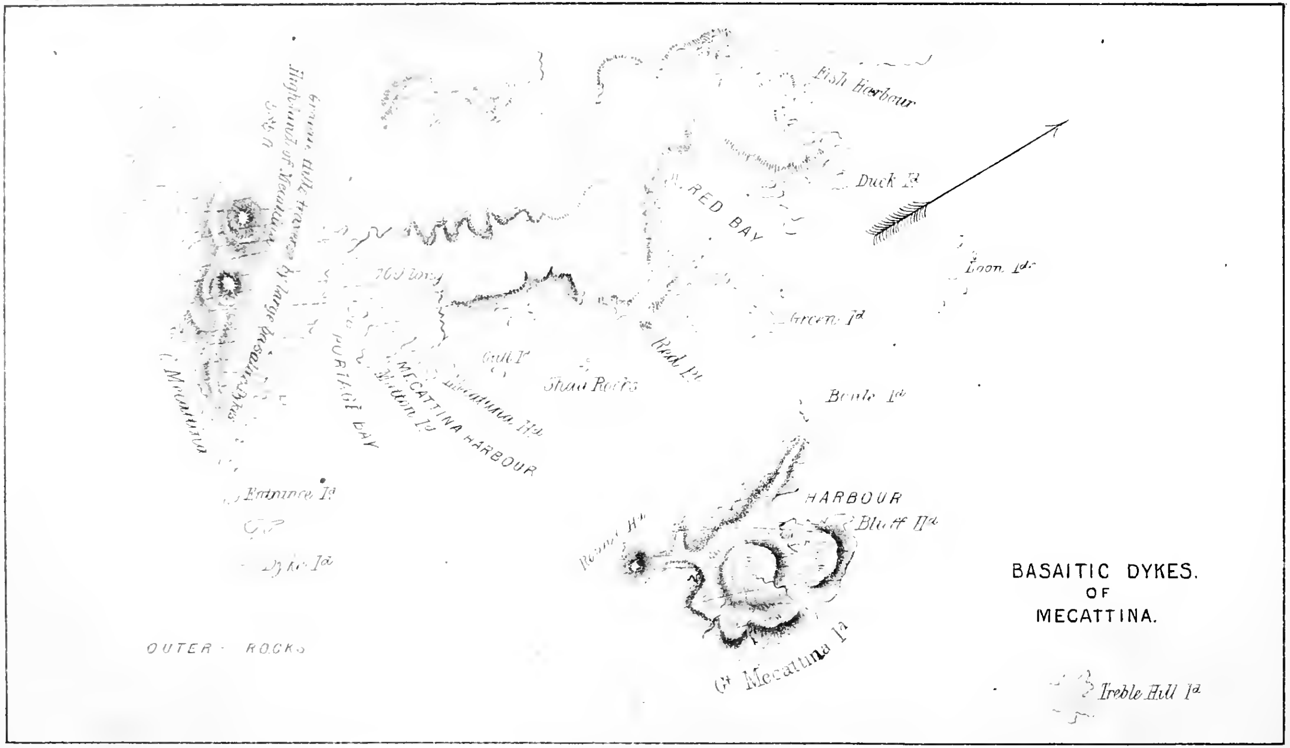
On the southern coast of Labrador, in the Gulf of St. Lawrence, is Chateau Bay, recognised from a vessel in the offing by the high land in the rear of it, and more especially by the two wall sided and flat topped hills, composed of basaltic columns, which cap the summit of Castle and Henley islands, two hundred feet above the sea. They somewhat resemble fortifications in the distance, and present a picturesque appearance when approached nearer; they shelter to the south and east Henley, Antelope, and Pitt's harbours, whilst Whale Island and York Point do so to the westward. Admiral Bayfield describes the two last named harbours as perfectly secure, and fit for the largest ships.

The geological formation of all the rocks and islands of the coast of Labrador belongs to the Laurentian system of Sir William Logan, and are the most ancient yet known on the continent of America. They extend from the north side of the Saint Lawrence from Labrador to Lake Superior, and occupy by far the larger share of Canada. They consist of gneiss, with interstratified bands of crystalline limestone, associated with layers of micaceous and hornblendic schists and quartzite. The colours of the rocks of this part of the coast vary from red to grey, and were formerly described as granite.

* Canadian Naturalist and Geologist, vol. ii., p. 4.

Castle Island is composed of gneiss, in which is found a mixture of a dark purplish grey felspar, fusible green hornblende and grey quartz, as observed by Capt. Campbell in 1827; the gneiss is capped by over-lying amorphous basalt fifty feet thick, nine hundred and ninety feet long, and two hundred and ten feet wide in its broadest part, which is near the centre. This mass of basalt is supported by an aggregation of basaltic columns, of which some reach to the height of twenty-five feet. They possess the usual characters, are vertical, in close contact, varying in size and the number of their sides, and are jointed. Capt. Campbell determined their base to be a hundred and eighty feet, with their summits two hundred and fifty-five above the water. This is fifty feet more than is mentioned by Bayfield; but, as the columnar and amorphous basalt have perpendicular sides, its thickness was made out by a plummet to be seventy-five feet, the feature of most importance in relation to the caverns. The summit is flat, and covered with moss and turf; its shape is oblong, and the columns pass all around it, and thus explains their fortification-like appearance on entering Henley Harbour. The island itself resembles a fish in shape, with a broad head, and having a distinct tail, which forms Chateau Point. It is a little over a mile and a quarter long, and a third of a mile broad at its northern part. (See map, plate vii.).

Henley Island is situated to the north-east of Castle Island, from which it is separated by a narrow channel leading into Henley Harbour, about a hundred and twenty yards wide, which is called by the fishermen Castle Reef Tickle. The shape of this island is that of a triangle, its most important side fronting towards the sea, and running due north and south; its southern side is hollowed out into two bays, which leaves the south-western part of the island in the form of a hill two hundred and four feet high, capped by the basalt as in Castle Island, and possessing all the characteristics peculiar to that island, with its pillars of the same substance. The extent of the basalt is about a fourth of that on the sister island, the width of this part of the island containing it being about two hundred and seventy-five yards. On that side only towards the sea (east) are the columns visible; but as three caverns are there present, it was looked upon by Lieutenant Baddeley, R.E., as strong presumptive evidence that these basaltic columns traversed the mountain, a supposition which it appears to me to amount to a certainty, on comparing the two islands with one another. In these caverns (which must at one time have been Fingal's Caves in miniature) the columns possess the same regularity and juxta-position as they do on the outside. The largest was found by Captain Campbell to be twenty yards deep by fifteen yards in the middle; the floors were strewn with the fragments of columns, and the sides were ornamented by those which their removal exposed to view; the ceiling was as smooth as that of a room, but of almost an iron blackness. The thickness of the amorphous basalt above was estimated at from thirty to forty feet, its course on both islands is from



BASAITIC DYKES.
OF
MECATTINA.

east to west, the columns to the westward are of larger dimensions than those to the eastward.*

The north-west side of Henley Island is bounded by Antelope Harbour, which is between it and the main land; whilst south of it lies the singularly-shaped Stage Island, which is low, and forms the western boundary of Henley Harbour. Within the entrance of Chateau Bay is Whale Island, which again lies in the entrance of Temple Bay. The basaltic columns of Henley and Castle Islands can be seen from the east point of Wreck Bay, two miles and a-half to the south-westward, and I think at one time they must have been united with a continuation of the basalt from one island to the other. (See map, plate vii.).

The only other part of British America where basaltic rocks are met with on a grand scale is on the shores of the Bay of Fundy. The northern side of the large island of Grand Manan, three to four hundred feet high, twelve miles south of Campo Bello, New Brunswick, at the entrance of the bay, is perfectly basaltic in many places, and resembles large pieces of squared timber placed upright side by side, with a perfection and beauty equal to the basaltic columns of Staffa. Whole façades of columns have been broken off and carried away by the sea.† Near the Old Bishop the basaltic columns stand erect, and apparently support the precipice, having five and six faces. A small uninhabited island at the entrance of the river Magaguadavic, is covered with basaltic pillars of from five to nine sides, many of them retreating into the sea. The celebrated cliffs of Cape Blomidon, in Nova Scotia, four hundred feet high, are composed of new red sandstone surmounted by crystalline basaltic trap, having a rude columnar structure, and presenting a perpendicular wall along the top of the precipice. For a general description of these cliffs the reader is referred to Dawson's Acadian Geology.

17.—Empty Basaltic Dykes of Mecattina. (See Map, pl. viii.).

Among the most singular peculiarities of the southern coast of Labrador, is the occurrence of empty basaltic dykes traversing Great Mecattina Island in a north-east and south-west direction from one side to the other, as described by Admiral Bayfield.‡ This island, composed of the Laurentian rocks, is about three and a-half miles long, north and south, about three miles wide, and is five hundred feet high at its centre; it is through these granitic (?) hills that the empty dykes run. These remarkable dykes, with the position of the islands, in relation to the high land inside of Cape Mecat-

* Trans. Lit. and His. Soc. of Quebec, vol. i. In Lieutenant Baddeley's paper, Castle Keep Rock is the name given to Castle Island, and Henley Island is erroneously called Saddle Island. There is a Saddle Island in Red Bay, some miles to the westward of York Point.

† Geol. Survey of New Brunswick. By Abraham Gesner, St. John, 1839.

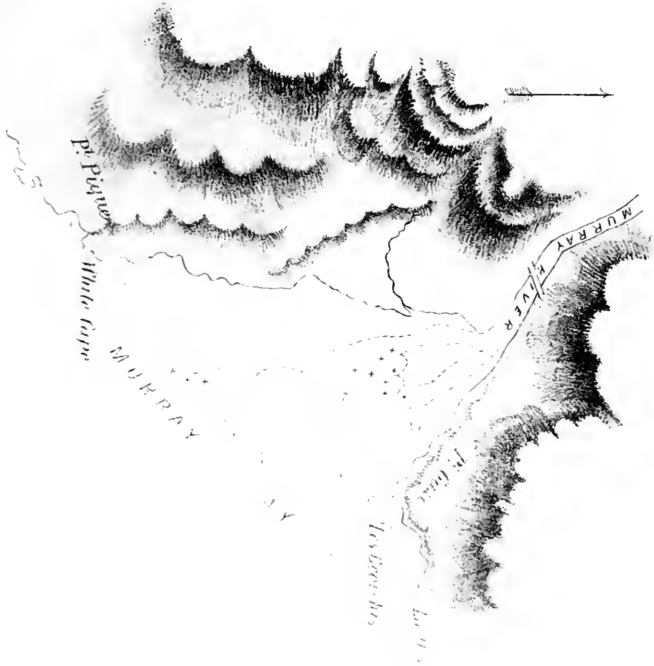
‡ Sailing directions of the Gulf and River St. Lawrence.

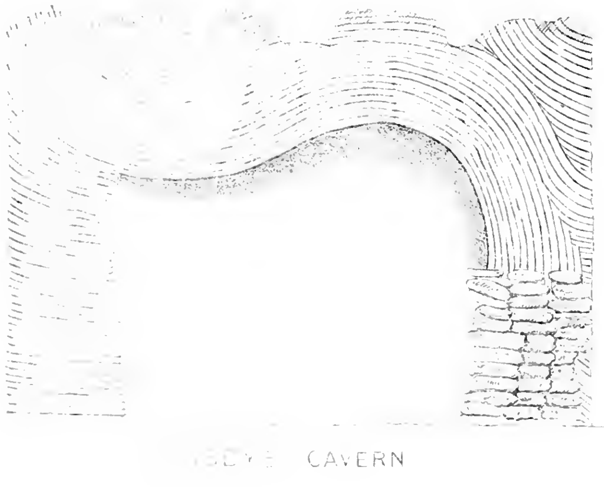
tina, which is four or five miles distant to the west north-west, are said to distinguish it from any other land in the Gulf of St. Lawrence. The nearest part of the main-land, Red Point, is rather more than two miles distant. Portage Bay, which is on the east of Cape Mecattina—a long and singular promontory of the mainland—runs in to the northward a mile and a-quarter between steep and high hills, fissured in the same manner as Great Island, with a rapid river at its head. The high land of Mecattina is seven hundred feet above the sea, and stands directly in rear of the harbour of the same name. It is not exceeded in height by any other land between Bradore and the Mingan Islands. Its granite is traversed from south-west to north-east by the same enormous basaltic dykes as are found on the Great Island. "They cut completely through the promontory into Portage Bay, ascending again on the eastern side of the latter, till they are lost to view beyond the summits of the hills. In Dyke Island several of them are empty as low down as the surface of the sea, dividing the island by immense open fissures in such a way as to distinguish it from all others in the neighbourhood."

What strikes the mind with wonder in examining these dykes is that the basalt should have become crumbled and worn away from decomposition in such a manner as to leave them quite empty, thus resembling more the character of fissures produced by an earthquake. That they are true basaltic dykes, however, is proved by finding the remains of basalt in some of them, and by examining the neighbouring land, which is comparatively free from them, unless in the places described. For if they were not these, we might expect to see numerous rents and fissures over a less limited area than they occupy. Similar phenomena are seen in many parts of Scotland, but in a minor degree. The empty dykes of Mecattina are probably the most extensive known, and I imagine assumed their present condition when the land was submerged.

18.—Bigsby's Cavern, Murray Bay.

On the northern bank of the St. Lawrence, ninety miles below Quebec, and six and a-half miles west by south from Cape Eagle, is the remarkable inlet known as Murray Bay, which is a mile and a-half wide, and nearly the same distance in depth. At its head is the rapid and unnavigable Murray River, which rises far in the interior, and flows down through a beautiful valley from several small lakes situated among the hills. At low water the bay is nearly dry, but there is anchorage for vessels close under the high rocky shore, a little to the eastward of the bay, as mentioned by Bayfield. The western point of the bay from eight hundred to one thousand feet high, is Point Pique, or White Cape, in which is situated Bigsby's Cavern; its eastern point is Point Gaze, or Les Ecorchis, and a little further on is La Heu; the way is directly opposite to Cape Diable,





[illegible] CAVERN

on the south shore, which is here ten and a-half miles across. (See sketch, plate ix.).

The prevailing rocks around Murray Bay belong to the Laurentian formation, their gneissic character being distinctly displayed in a set of beds on the west side of the bay above White Cape, marked by diversities of colour allied to red, green, black, and white; these beds are described as granitic but very quartzose, with some bands among them possessing the aspect of a slightly micaceous quartz rock. Among the beds is a large grained red granitic dyke, running in general with their strike, which is north-west, at an angle of from thirty to thirty-five degrees. On the east side of the bay, near Les Ecorchis, the gneiss presents the aspect of a dark grey compact slightly micaceous hornblende slate. It is here also cut by a very coarse-grained dyke, running generally with the stratification, and consisting of quartz and opaque white felspar, while hornblende prevails on each side of the dyke towards its contact with the gneiss. Still further to the eastward, before reaching La Heu, there is a very great white dyke of a similar character. No interstratified bands of crystalline limestone belonging to the Laurentian formation are here met with. The Potsdam sandstone, or white quartz rock, appears above White Point, and at two spots at the east side of the bay. At White Cape the calciferous sand rock is next observed; it composes the point which bounds the boat cove on the south. The beds here are about twenty-three yards broad with a thickness of fifty-eight feet, and the rock is described as a calcareous sandstone. possessing arenaceous layers interstratified with occasional bands of limestone; the last forms the uppermost bed as well as a few at the bottom. In some of the arenaceous beds translucent milky quartz-pebbles exist as large as hens' eggs, thus constituting them into conglomerates; but the grains are generally of such small size as to give an oolitic appearance to the rock: they consist both of limestone and quartz.* Dr. Bigsby found some of the nodules as large as a child's head. To the west of the boat cove are two hummocks of the rock, forming the bluff from which White Cape takes its name.

The conglomerate which thus composes the chief part of the precipice of White Cape is described by Dr. Bigsby as in strata more than a foot thick, abutting against mica slate in various unconformable positions.—"At the west end the layers are very thin, and are placed vertically, with a south-west direction, in some degree of parallelism to the contiguous mica slate. Near this they are contorted, until gradually toward the centre of the range they become horizontal. Here a singular disposition of the upper laminæ is observed. They roof a shallow cave in undulating lines, which descend gently from above, and after curving upwards for a short distance, decline suddenly on the horizontal strata which constitute the lower half of the sides of the cave."† (See sketch, plate ix.).

* Geol. Survey of Canada. Report for 1849-50.
† Amer. Jour. of Science, vol. v., p. 212. 1822.

This cavern was also examined by Lieut. Baddeley, in 1828, who describes* the sides and roof as coated in many places with a white incrustation, having none of the crystalline aspect of stalactite, being softer and more resembling analagous appearances on the roofs of old brick or stone arches. It descends very rapidly for a few yards, when it suddenly narrows to a mere crack, admitting the passage of a boy or small person into a more spacious cavern, which had not been explored.

Bigsby's Cave has been known for some years, and has been noticed in some of the Canadian newspapers as, I believe, the Grotto of St. Paul; this is on the testimony of the Rev. Jos. M. Bellenger. None of these accounts could I lay my hands on; and as the first notice of the cavern was from the pen of Dr. Bigsby, it seemed to me quite proper that it should be called after him. It is not at all improbable that it has been further explored, through the able assistance of Dr. Fraser, of Murray Bay, and a more extended account published of its interior; in the present, however, especial pains have been taken to describe the nature of the rocks which exist in its vicinity. In Murray Bay and on the coast below, the Trenton limestone presents upwards of six miles to the St. Lawrence, and runs as many up the Murray Bay River, with a general breadth of two miles.

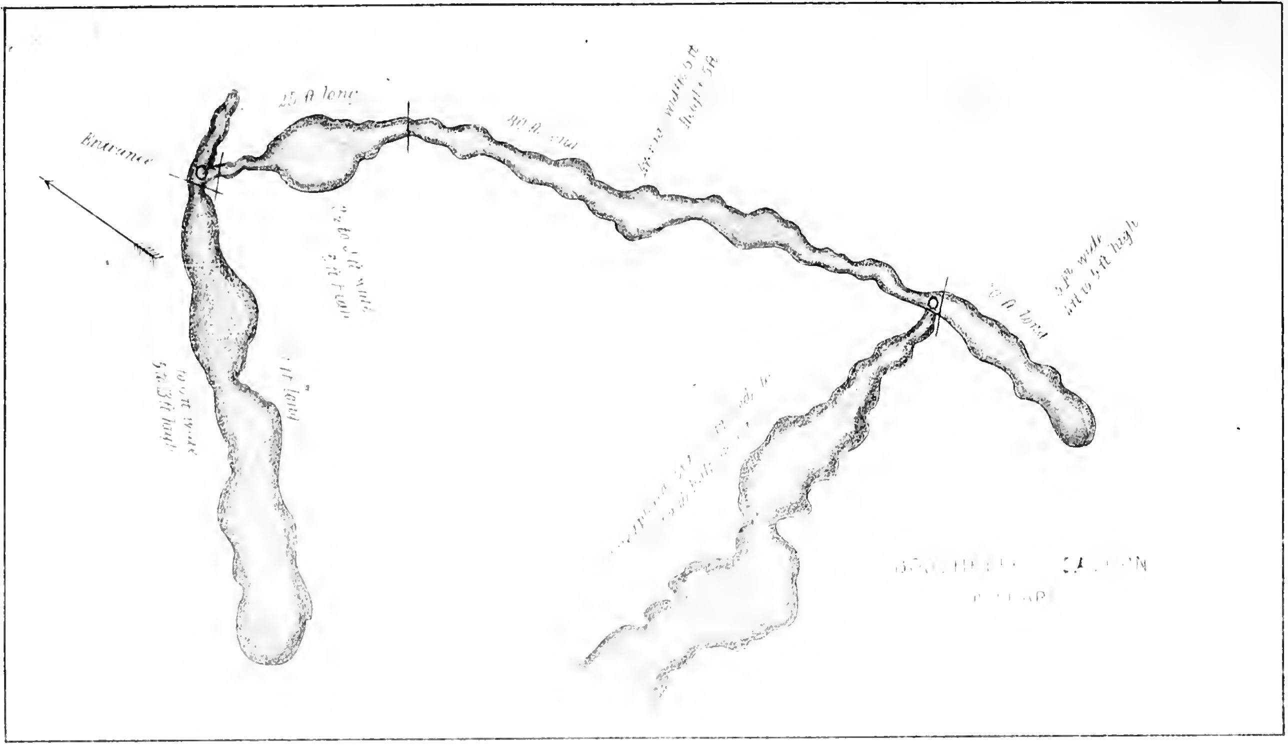
Dr. Bigsby found a brown or black splintery slate often interposed between the conglomerate and the dark limestone, which was plentiful at the cave. The curvature of the strata at the cavern at the west angle of Murray Bay and of the east shore of the Bay are objects of interest, and furnish "an additional evidence showing the temporary flexibility of rocks after consolidation, and their disturbance while in that condition." At the mouth of the grand river St. Anne, twenty-four miles below Quebec, Dr. Bigsby noticed three strong seams of grauwacke form as many concentric arches in the face of a naked and perpendicular bank, the outer of which is about eight feet high, and twenty-two feet span, the surrounding shale observing the same position; and at the bridge of the river Jaques Cartier, thirty miles above Quebec, there is a beautiful natural arch of blue limestone of similar dimensions.

There are very few places in Canada to be compared to Murray Bay for the beauty of its scenery and the surrounding features of geological interest. Here can be seen an instructive assemblage of the most ancient rocks, and an abundance of their characteristic fossils, among which are fine examples of *Orthoceratites*, to repay the zealous investigator. Slight shocks of earthquake are not unfrequent in this neighbourhood, and it is related that they occur nine or ten times annually.

19.—Bouchette's Cavern, Kildare.

This cavern was visited and first described by Colonel Bouchette (Surveyor-General of Canada) in the report of his official tour

* Tran. Lit. and His. Soc. of Quebec, vol. i.


Entrance
25 ft long
80 ft long
9 ft long
5 ft long

through the new settlements of the lower province in 1824. It is situated in the township of Kildare, about thirty-five miles due north of the city of Montreal, but the precise locality I have been unable to determine, although from the decsription it may be close to the village of the same name. The southern half of the township is traversed by a broad band of the Potsdam sandstone, in continuation of the same rock running in a north-east direction from the south-western part of the township of Rawdon. That part of Kildare north of this band is composed of gneiss of the Laurentian system, most probably interstratified with some bands of crystalline limestone, in which the cavern is developed.

It was about the year 1822 that two young Canadian peasants, whilst prosecuting their sport of hunting the wild cat, pursued two of their game, until entering an obscure hole a little above the bank of the river, they lost sight of them. The more enterprising of the two attempted to enter the aperture in the rock, at that time barely sufficient to admit of his crawling into it, but without success. Providing themselves with lights, a second attempt was more successful, for " not only did they secure their prey (of which they have preserved the skin to this day), but they discovered," says Colonel Bouchette, " another of the many phenomena of nature, a description of which cannot be uninteresting."

The following account is given in the Colonels's words :—

" I descended into the cavern by means of a trap-door, which has recently been placed at one of its angles for the facility and convenience of strangers desirous of visiting this singular spot, having as my guides two of the inhabitants of the neighbouring house, bearing lighted tapers. The height of the cave where we entered is five feet, from which angle branch off two caves, the lesser whereof is of the following dimensions :—

Length		25 feet.
Breadth varying from	$2\frac{1}{2}$ to	9 ,,
Height		5 ,,

It bears about a south-east course from the entrance.

The other has in length		70 feet
Width from	7 to	8 ,,
Height, gradually increasing	5 to	13 ,,

" The increase in the loftiness of the cave originates from the declivity of the ground part, which, at the north-eastern extremity, is at least twenty-three feet from the surface. It forms nearly a right angle with the first, at its south-western end, and an angle scarcely obtuse at the other with another cave, whose

Length is	80 feet
Average width	6 ,,
Height	5 ,,

At the south-eastern extreme of this cave branches off another of inferior size and consequence, bearing about a due south course, as may be deduced from the angle it makes with the last described.

It is in length	20	feet
Width	5	„
Height	5 to 4	„

"At the outward angle formed by this cave with the preceeding one, is to be seen a nearly circular aperture of about a foot and a half in diameter, which leads to a cavern yet unexplored, the extent whereof is not known with any certainty; but conjecture and supposition will have it to extend two arpents—an astonishing distance as a natural subterraneous passage. Summing the lengths of the several caves above-mentioned together, we have a total distance of a hundred and ninety-five feet of subterranity in the solid rock, offering a beautiful roof of crystallized sulphurate of lime, carved as it were by the hand of art, and exhibiting at once the sublimity of nature, and the mastery of the all-powerful Architect of the universe." (See plan, plate x.).

From the foregoing description there would seem to be five different caverns or galleries, and probably many more, if the fifth has been since explored. Three of them branch off from the entrance in different directions, whilst the remaining two do so at the termination of the central gallery. The roof throughout is covered with stalactites, but as no mention is made of stalagmite, nor of the presence of bones, we are left to conclude that they were absent, although the chances were much in favour of finding the latter, in consequence of there being a free and unobstructed entrance into the cavern.

20.—Gibb's Cavern, Montreal.*

This cavern, which is of humble pretensions as to size, is situated in the Island of Montreal, and no account of it had appeared before the one which I published in the "Canadian Naturalist and Geologist" for June, 1858. My attention was first drawn to it by my friend Dr. Robert Nelson, formerly of Montreal, and now of New York.

The cave exists on the border of a limestone ridge, running in a north-east and south-west direction, which skirts a number of farms back of the main road at Côte St. Michel. Its dimensions are twenty-five yards or more in depth, with a width of two or more yards. The latter varies a good deal and is somewhat irregular, but the roof is considerably wider than the floor, which is covered with water to the depth of some feet. A part of the floor will permit of a

* The association of my name with this cavern by a friend is my excuse for retaining it here.

footing, and when in the cave a person can stand upright, with plenty of room to spare. The roof is composed of limestone, and lined with a coating of stalactitical carbonate of lime, but from which there do not project any stalactites; some portions of the floor, however, contain stalagmites, a few specimens of which were collected. No bones of animals were found, possibly owing to the presence of the water. Their existence can only be ascertained by pumping the water out, which may overlie a sort of breccia. The ridge, which is composed of the Trenton limestone, here partakes somewhat of the character of a hill, at the base of which is an opening leading into the interior of the cavern. It was accidentally discovered some thirty years ago on the occasion of a party of *habitans* going out hunting. The dog belonging to the party commenced to scratch at the spot which forms the entrance, and suddenly disappeared; the animal had fallen into it, and his cries brought the hunters to the hole in the ground. The opening was enlarged, and the party entered by crawling on their hands and feet.

From the description of the cavern, it would appear that its origin is due to upheaval from below, producing a dislocation of the stratum of limestone and the formation of a wide fissure, which may be found ultimately to extend much farther than the distance given in the foregoing account. The discovery of this cavern was looked upon at the time as something very wonderful.

(To be continued.)

THE CARBONIFEROUS SYSTEM IN SCOTLAND CHARACTERIZED BY ITS BRACHIOPODA.

By Thomas Davidson, Esq., F.R.S., F.G.S., Hon. Member of the Geological Society of Glasgow, etc., etc.

(Continued from Vol. iii., *p.* 115.*)*

XXXVI.—Productus costatus. Sow. Pl. ii., figs. 22-24; pl. iv., fig. 25.

Producta costata. J. de C. Sowerby, Mineral Conchology, vol. vi., p. 115, pl. dlx., fig. 1, 1827.

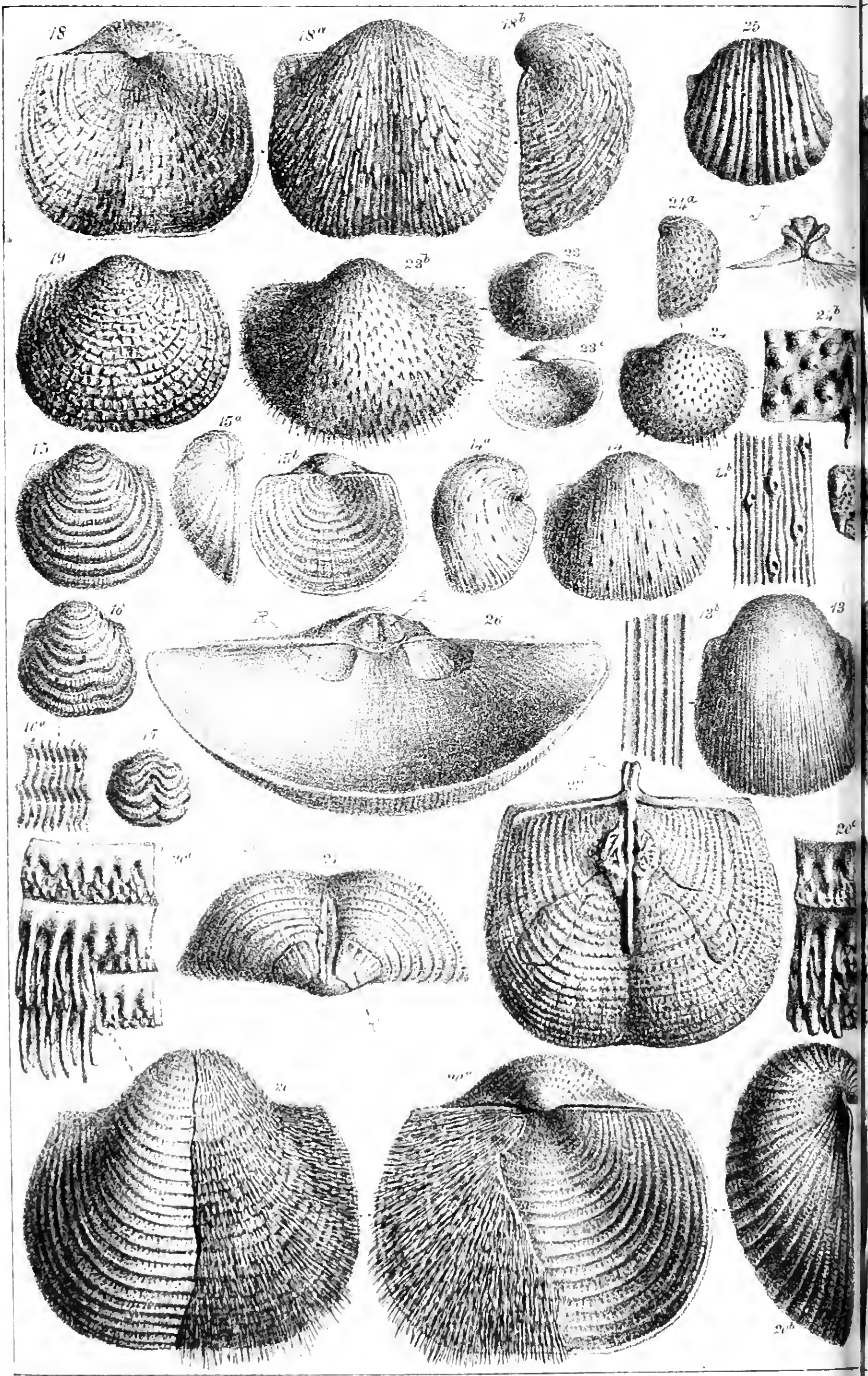
This species appears to vary somewhat in appearance, but is usually transversely semi-cylindrical, the hinge-line being at the same time the widest portion of the shell. The ventral valve is very much vaulted, and usually longitudinally divided by a median depression or sinus of variable depth. The beak is small, and does not overlie the hinge-line, while the ears are of moderate dimensions and clearly defined. Exteriorly the surface is ornamented with numerous longitudinal ribs, which increase in number by means of occasional intercalations; certain ribs will also disappear before having attained the

margin; while again two will sometimes unite, so as to constitute but a single rib. The costæ are very often of unequal width, rounded, or flattened, and sometimes will rapidly increase in width as they extend towards the margin: concentric wrinkles are also observable upon the auriculate portions of the valve, and a row of long tubular spines may be seen close to the cardinal edge, as well as upon the lateral portions of the beak; spines of smaller proportions project likewise here and there from the ribs themselves, while the longitudinal costæ are closely intersected or decussated to some distance from the extremity of the beak by numerous undulating concentric lines. The dorsal valve is concave, but much flattened to some distance from the hinge-line, while the sculpture is very similar to that visible upon the opposite valve. No interiors of this shell appear to have been hitherto discovered, nor did it ever attain very large proportions; some Scottish examples have measured one inch and a-quarter in length by about one inch and three-quarters in breadth.

In his "Monographie du Geme Productus," Prof. de Koninck placed *P. muricatus*, Phillips, among the synonyms of the species under description; but as the figure in the "Geology of Yorkshire" had given rise to some uncertainty, I requested and obtained, through the kind medium of Mr. Dallas, the loan of the original example, preserved in the Museum at York. It differed, however, from the representations that had been given of it in the "Geology of Yorkshire," by presenting a well marked median depression in the ventral valve, but agreed very closely with certain similar shells found by Mr. Thomson at Cessnock, in Ayrshire, and of which fig. 25 of our pl. iv. is an example. The presence of so many small tubular spines along the upper surface of all the ribs is a character not observable upon the larger number of specimens of *P. costatus*; and from this character alone I should almost have been inclined to separate the last-named shell from *P. muricatus*, had not an undoubted example of the first, in the collection of Dr. Slimon, exhibited a number of similar spines along the surface of the ribs. *P. costatus* is not a very rare species in Scotland; it occurs at Hill Head, in Lanarkshire, at three hundred and seventy-five fathoms below "Ell coal;" also at Brockley, near Lesmahago. In Stirlingshire, in the Campsie main limestone. In Dumbartonshire, at Castle-cary. In Renfrewshire, at Barrhead. In Ayrshire, at Roughwood and West Broadstone, Beith; Goldcraig and Monkredding, near Kilwinning; Auchenskeigh, Dalry; Meadowfoot, near Drumclog; and Cessnock, parish of Loudon. In Buteshire, in the island of Arran.

XXXVII.—Productus Youngianus. Dav. Pl. ii., fig. 26, and pl. v., fig. vii.

This shell is longitudinally very oval, the hinge-line being rather shorter than the width of the shell. The ventral valve is regularly arched and without any sinus, while the auriculate expansions are very small; and the beak, which is comparatively large, does not overlie the hinge-line, except quite at its attenuated extremity. The dorsal valve is concave, and follows the curves of the opposite one; exteriorly the surface is ornamented with numerous small rounded ribs, of which a certain number are due to intercalation, and from which at short distances project slender tubular spines; these appearing more widely scattered in some specimens than in others. Undulating concentric lines of growth are likewise observable, and in some specimens appear to have been continued in the form of very thin and short concentric lamelliform expansions, but which are on the greater number of specimens broken off close to the shell, so that when perfect they must have presented a somewhat fringed appearance. These lamelliform expansions, which lie close to the surface, appear to have been more strongly developed or displayed in the young shell, and with age the striæ became more regularly marked, which leads me to suppose that when quite adult the shell assumed the appearance of the specimen,



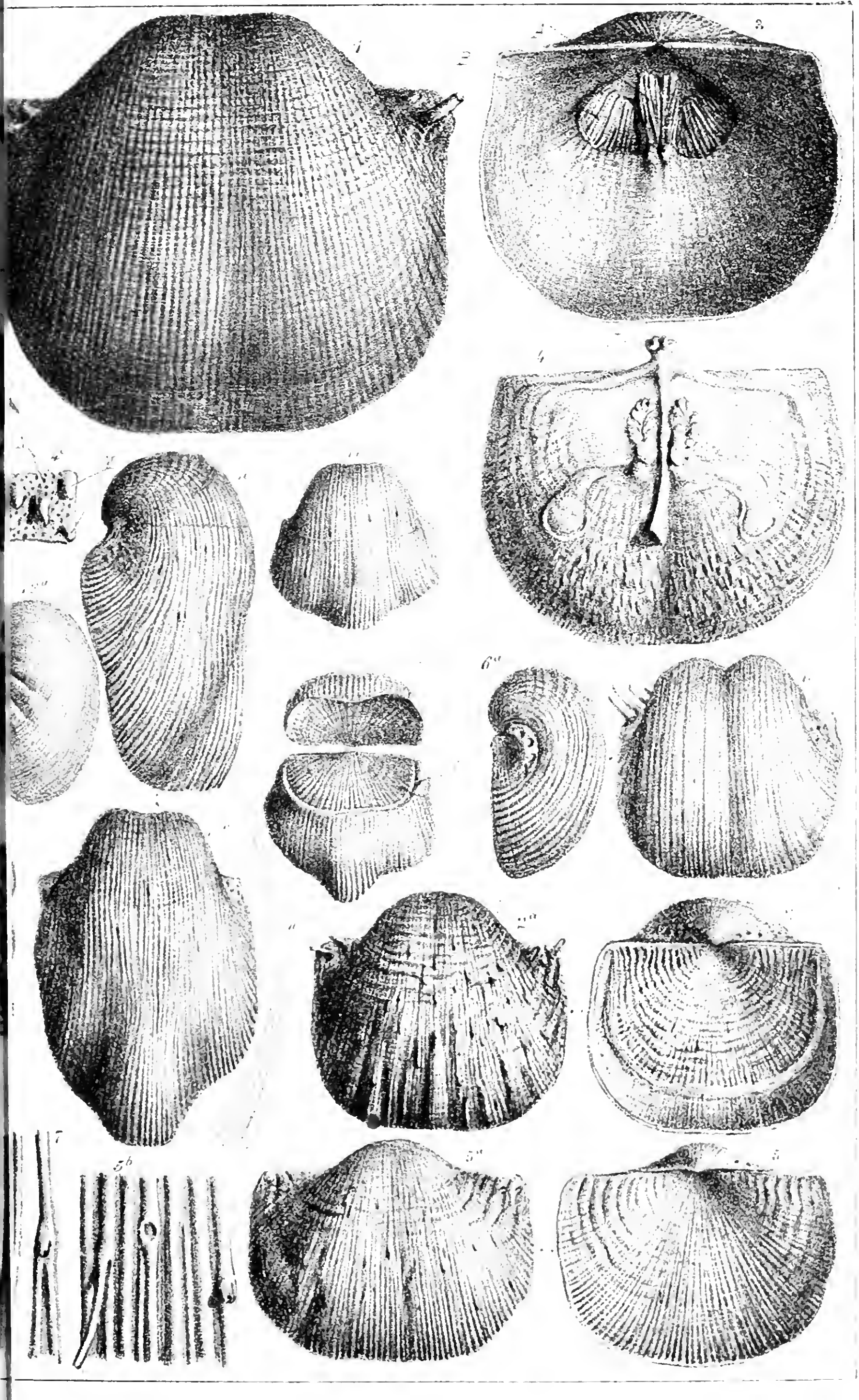


fig. 25; but of that I do not at present feel certain. Mr. Young has seen examples of this shell from Lanarkshire, Renfrewshire, Ayrshire, and Fifeshire, but it is nowhere (yet discovered) so plentiful as at Corrie Burn, where it occurs in a thin bed of a white friable shale, above a coralline bed (*Lithodendron fasciculatum*, Fleming, = *Lithostrotion Martini*, M-Edw.). It is found also at Brockley, near Lesmahago, in Lanarkshire.

For some time I felt uncertain whether the shell under description might not be the same as that to which Messrs. Norwood and Pratten had applied the name of *elegans*; but having received from Mr. Worthen and Prof. de Koninck several typical examples of the American shell obtained at Chester, Illinois, I soon became convinced that the Scottish species was in reality distinct. Messrs. Norwood and Pratten have not, however, furnished us with a characteristic representation of their species, which is not evenly convex, but longitudinally flattened, and even sometimes depressed along the ventral valve in the many American specimens that have come under my observation; while, on the contrary, our *P. Youngianus* is always regularly convex and without mesial depression; it is likewise much more regularly oval, and the sides of the beak do not fall perpendicularly upon the ears as in *P. elegans*, and, although distinct, approaches mostly to *P. aculeatus* of Martin. Mr. Salter assures me that there are none of Prof. Hall's figures in the Iowa report at all like our Scottish shell. I have, therefore, ventured to name the shell after Mr. J. Young, of the Hunterian Museum of Glasgow, who was the first to draw my attention to the species; and I am indebted to Mr. Salter for the loan of a specimen from the carboniferous limestone of Llangollen, in Wales, which may be seen in the Museum of Practical Geology.

XXXVIII.—Productus aculeatus. Martin. Pl. ii., fig. 20.

Anomites aculeatus. Martin, Petrif. Derb., p. 8, pl. xxxvii., figs. 9-10, 1809. Productus id., De Koninck, Monographie du Genre Productus, pl. xvi., fig. 6.

The shells composing this species are usually nearly circular, or slightly longer than wide, the hinge-line being at the same time shorter than the greatest width of the shell. The ventral valve is evenly convex, and without sinus, while the dorsal one is very concave, closely following the curves of the opposite valve. The ears are very thin and small, usually broken; the beak also, which is much incurved, does not overlie the hinge-line, except quite at its attenuated extremity. On the exterior of the valves there exists some irregularly scattered elongated tubercles, from which projected short adpressed spines, these tubercles being also sometimes so elongated as to produce the appearance of ribs; but both Martin and Sowerby were mistaken, as was justly observed by Prof. de Koninck, when they stated in their descriptions of the shell that the spines "pointed backwards, or towards the beak." Numerous concentric undulating lines of growth may also be detected on either valve. The interiors of the valves have not been hitherto discovered; and although the species does not appear to have ever attained large dimensions, those known to me from Scotland did not exceed some five lines in length by four and a-half in width.

In Scotland the shell has been found in several localities. In Stirlingshire it occurs in the Campsie main limestone and ironstone. In Lanarkshire it has been found at Calderside, High Blantyre. In Renfrewshire, at Orchardquarry, Thornliebank. In Ayrshire, at West Broadstone, Beith; Craigie, near Kilmarnock; and Auchenskeigh, Dalry.

XXXIX.—Productus spinulosus. J. Sowerby. Pl. iv., figs. 23-24.

Productus spinulosus. J. Sowerby, Min. Con., vol. i., p. 154, pl. lxviii., fig. 3, 1814. De Koninck, Monographie du Genre Productus, pl. xi., fig. 2.

This shell is transversely semicircular, the hinge-line being nearly as long as the greatest width of the shell. The ventral valve is regularly convex, and evenly arched, without sinus; the beak incurved, and not overlying the hinge-line, except quite at its attenuated extremity. The ears are flattened, with a few concentric wrinkles. The dorsal valve, which is very concave, follows the curves of the opposite one. Externally the surface is covered with numerous short spines, arranged in quincunx, and generally about half a line or so apart: they originate from a small slightly elongated tubercle, which alone is usually present in the fossil. The interior arrangements are unknown, and the shell does not appear to have ever attained large proportions, some Scottish examples that have come under my observation having measured seven and a-half lines in length by nine in width; and it is always easily distinguished from other Scottish species of Productus by its shape, as well as by the peculiar quincunx arrangements of its slender spines.

In Lanarkshire *P. spinulosus* has been collected at Nellfield and Hill Head, at three hundred and seventy-five fathoms below the "Ell coal;" also Brockley, near Lesmahago. In Ayrshire, at West Broadstone and Auchenskeigh, near Dalry. Prof. Fleming's original specimen, which is figured on our plate, was from Linlithgowshire. In Haddingtonshire, at Cat Craig, near Dunbar.

XL.—Productus mesolobus. Phillips. Pl. ii., fig. 21.

Producta mesoloba. Phillips' Geol. of Yorkshire, vol. ii., p. 215, pl. vii., figs. 12-13, 1836, and De Koninck's Mon. du Genre Productus, pl. xvii., fig. 2.

This shell is transverse, with a very long straight hinge-line. The auriculate expansions project and form attenuated cardinal extremities, while the lateral margins are rounded, and straight or undulating in front. The ventral valve is very gibbous at the beak, and sometimes geniculated towards the front, with a wide flattened or slightly concave sinus, interrupted in the middle by a narrow median rib: on either side of the sinus a similar ridge or rib is present, and another intervenes between these and the cardinal angles. On the five ridges may be seen a few tubercles, from which projected small tubular spines. The beak is of moderate size, and not overlying the hinge-line, except quite at its attenuated extremity. The dorsal valve is concave, with a narrow median groove and two slightly marked lateral ones: concentric lines of growth are observable upon both valves. The interior of the valves are unknown; and the largest Scottish example that has come under my observation did not exceed eight lines in length by thirteen in width, but the shell has elsewhere attained large proportions, and can always be easily recognized on account of its peculiar shape and character.

At Braidwood, in Lanarkshire, it has been found at three hundred and seventy-five fathom below the "Ell coal." At Brockley, near Lesmahago. In Stirlingshire, in the Glarat lime works or Campsie main limestone. It does not appear to be a very common species in Scotland.

XLI.—Productus pustulosus. Phillips. Pl. iv., fig. 19.

Producta pustulosa. Phillip's Geol. of Yorkshire, vol. ii., pl. vii., fig. 15. 1836.

This shell is rotundato-quadrate, rather wider than long, with a straight hinge-line, somewhat shorter than the greatest width of the shell. The ventral valve is gibbous, with a wide shallow mesial sinus; the beak being moderately developed and incurved, but not overlying the hinge-line; the auriculate ex-

pansions are wide, flattened, and clearly defined. The whole surface is covered with numerous somewhat irregular transverse undulated wrinkles, while numerous elongated pustules or tubercles are closely scattered over the entire surface, and from which projected small adpressed tubular spines. The dorsal valve is but slightly concave, with a small mesial elevation or fold; it is likewise ornamented with numerous transverse wrinkles and elongated pits in lieu of the tubercles observable in the opposite one.

No Scottish interiors of this shell have been hitherto discovered; but English specimens show that the muscular and other impressions did not differ materially in detail from those of *P. scabriculus* and of others described in this monograph. *P. pustulosus* sometimes attained large proportions; but the only Scottish example I was able to examine did not exceed some eleven lines and a-half in length by fourteen in width.

In Haddingtonshire it is stated to occur at Cat Craig, near Dunbar; and another example, labelled from the north of Glasgow,* is preserved in the Museum of Practical Geology. In Stirlingshire a specimen was found in shale, under the Campsie main limestone by Mr. G. Somervile.

The sixteen species of Productus described as having been found in Scotland form part of Prof. de Koninck's following groups:—

STRIATI	*Productus giganteus*, Martin sp.
	——— *latissimus*, J. Sowerby.
	——— *cora*, d'Orbigny.
UNDATI	——— *undatus*, Defrance.
SEMIRETICULATI	——— *semireticulatus*, Martin sp.
	Var. *Martini*, Sowerby.
	——— *costatus*, J. Sowerby.
	——— *Youngianus*, Davidson.
	——— *longispinus*, J. Sowerby.
	——— *carbonarius*, de Koninck.
SPINOSI	——— *spinulosus*, Sowerby.
	——— *scabriculus*, Martin sp.
	——— *pustulosus*, Phillips.
FIMBRIATI	——— *punctatus*, Martin sp.
	——— *fimbriatus*, J. Sowerby.
CAPERATI	——— *aculeatus*, Martin sp.
MESOLOBI	——— *mesolobus*, Phillips.

It is probable that in time better and more abundant materials relative to some few of the species will be discovered, and which will enable palæontologists to determine more exactly whether one or two of those above enumerated might not be mere varieties of some already recorded species; and again whether we are justified or otherwise while considering *P. Martini* as a simple variation in shape of *P. semireticulatus*.† Interiors of *P. undatus*,

* The exact Scottish locality from whence this specimen, *P. carbonarius*, and *Sp. pinguis* were obtained appears to be unknown. These specimens, which have all the appearance of Scottish shells, are labelled "north of Glasgow" in the Museum of Practical Geology, but were in all probability derived from some other portion of the country, for otherwise it would be strange that no examples of the two last have been met with by any of the collectors who have explored with much care the numerous localities to the north of Glasgow.

† Mr. G. Tate, as well as some other palæontologists, seem desirous of retaining *P. semireticulatus* and *P. Martini* as separate species; and Prof. de Koninck informs me that he now feels uncertain whether the two should be considered as distinct. These shells have been described separately in this monograph, as var. *semireticulatus* and var. *Martini*; and may therefore be retained as specific denominations by those who might consider such a thing desirable.

P. costatus, *P. Youngianus*, *P. spinulosus*, *P. fimbriatus*, *P. aculeatus*, and *P. mesolobus* are also desiderata, and which will no doubt turn up sooner or later, and thus enable palæontologists to complete the descriptions of those well marked species.

Genus Chonetes. Fischer. 1837.

As the character of the genus or sub-genus will be described under *C. Hardrensis*, we need not in this place do more than to briefly observe that the distinctly articulate hinge is the chief character by which *Chonetes* has been separated from *Productus*; and that if those shells described by myself in the Journal of the Geological Society as *Chonetes comoides* with strongly articulated hinges belong in reality, as supposed by Prof. de Koninck, to *P. hemisphæricus* (Sowerby), or to *Productus* at all, the regular articulation or non-articulation of the valves could no longer be made use of as a character by which the two groups could be distinguished. There is also a slight difference in the disposition of the quadruple impressions of the occlusor muscle in the dorsal valve of *Chonetes*, which may claim attention. *Chonetes*, as well as *Productus*, possessed scattered tubular spines over its external surface; but the disposition of those along the cardinal edge of Chonetes is one of its less important distinguishing features. We may also remark that although the general character of *Productus* is not to possess definite area, fissure, or pseudo-deltidium, these are by exception present in some species of the last-named genus.

A great many so termed species of carboniferous Chonetes have been recorded in different works, but which could be most advantageously and properly reduced to a very small number; and it has appeared to me that palæontologists have often forgotten that the ribs which ornament the species of this genus were liable to become coarser or finer, fewer or more numerous, according to the specimen or individual, as is the case with species of other genera.

Rightly or wrongly, I have reduced the Scottish species to two only, *C. Hardrensis* and *C. Buchiana*. Prof. Ramsay mentions *C. papilionacea*, Phillips sp., with a point of doubt, as one of the shells he obtained in Arran; but as all my efforts to obtain the sight of a Scottish example of that species have proved ineffectual, it is probable that the species has not been hitherto discovered.

(To be continued.)

NOTES AND QUERIES.

Geology of the Province of Auckland, New Zealand.—Sir,—The following particulars of the geology of Auckland, New Zealand, may be of interest to some of your readers. They are condensed from the remarks of Dr. F. Hochstetter, in a lecture delivered to the members of the Auckland Mechanics' Institute during the past year; and are the results of the geological survey of those parts of the country which the Doctor has made.

Having completed his survey and a geological map of the Auckland district, he chose the southern portion of the province for his farther researches. The country there is inhabited almost exclusively by Maories, and has hitherto been almost unknown, both topographically and geologically; the northern dis-

tricts, on the contrary, being better known, from the number of European settlers in them.

Through the arrangements of the General and Provincial Governments Dr. Hochstetter was enabled in a comparatively short time to travel over and to examine the larger portion of the province south of Auckland, extending as far as Lake Taupo and the Tongariro Volcano, the boundaries between this province and those of Wellington and Hawke's Bay.

The observations have, with the able assistance of Mr. Drummond Hay, extended from the east to the west coast; and the numerous peaks and ranges have afforded facilities for fixing with satisfactory accuracy, by means of magnetic bearings, on the basis of points previously fixed by the nautical survey of Capt. Drury on the coast line, all the great natural features of this portion of the country. A great number of barometrical observations have afforded the means of ascertaining the heights of mountains and plains in the interior, which can thus be calculated with accuracy by the aid of corresponding daily observations, taken in Auckland by Colonel Mould. Photographic and other views of great interest have been taken; and a large number of exceedingly valuable sketches have been contributed by the talented pencil of Mr. C. Heaphy, for future publication in a geological atlas. Dr. Hochstetter acknowledges also the assistance he has received from Mr. J. Crawford, at Wellington; Mr. A. S. Atkinson, of Taranaki; Mr. Triphook, of Hawke's Bay; Mr. H. T. Kemp, of the Bay of Islands; to the missionaries; and to almost innumerable friends in Auckland.

The first striking characteristic of the geology of the province of Auckland, and probably of the whole of the northern island of New Zealand, is the absence of the primitive, plutonic, and metamorphic formations, as granite, gneiss, mica-slate, and the like. "I have been informed by Mr. Heaphy," says Dr. Hochstetter, "that these rocks are of wide-spread extent in the Middle Island, forming mountain-ranges of great altitude, covered with perpetual snow, and reaching in Mount Cook probably to thirteen thousand feet." The rocks of these formations contain the principal metallic riches of the earth. Therefore we cannot hope to find these riches developed in the highest degree in the Northern Island; but as other formations also contain metalliferous veins, there may be found many mines worth working in the rocks I am about to describe.

The oldest rock I have met with in the province of Auckland belongs to the primary* formation. It is of very variable character, sometimes being more argillaceous, of a dark blue colour—when decomposed, yellowish brown, the colour generally presented on the surface—and more or less distinctly stratified like clay-slate, at Maraitai on the Waitemata; at other times the siliceous element preponderates, and, from the admixture of oxide of iron, the rock has a red, jasper-like appearance, at Waiheki, Manganese Point. In other localities it is more distinctly arenaceous, resembling the old sandstones of the Silurian and Devonian systems, called grauwacke, at Taupo, on the Hauraki Gulf.

As no fossils have yet been found in this formation in New Zealand, it is impossible to state the exact age. I am, however, of opinion that these argillaceous siliceous rocks will be found to correspond with the oldest Silurian strata of Europe.

The existence and great extent of this formation are of considerable importance to this province, as all the metalliferous veins hitherto discovered, or likely to be hereafter found, occur in rocks of this formation.

To these rocks belong the copper-pyrites, which has been worked for some years at the Kawau and Great Barrier, the manganese (psilomelan) at Waiheki, and the gold-bearing quartz at Coromandel.

* The word primary is used throughout as an equivalent term to our Palæozoic.

The gold which is washed out from beds of quartz-gravel in the rivers and creeks flowing down from both sides of Coromandel range, is derived from quartz veins of crystalline character and considerable thickness, running in a general direction from north to south, through the old primary rocks which form the foundation of the Coromandel range. In some places these veins stand up like a wall on the summit of the range to a height of eight or ten feet. The clay-slate rock itself is exposed only at the bottom of deep gorges which form the channels of the principal streams. In almost all places it is covered by large masses of trachytic tuff and breccia, of which the hills surrounding the harbour of Coromandel are composed. The well-known "Castle Hill," which can be seen from Auckland, is a characteristic example of the trachytic breccia formation. The magnetic iron-sand, which, in washing, is found with the gold, is derived from the same source as all the magnetic iron-sand of New Zealand, namely, from the decomposition of trachytic rocks. Small veins of quartz of amorphous character—that is, not crystalline, but in the shape of chalcedony, cornelian, agate, and jasper—are found in numerous places on the shores of Coromandel. These veins occurring in trachytic rocks, are quite different from the auriferous quartz veins in the primary formation—a fact, I think, of much practical importance to state, to prevent the fruitless search for gold where gold does not exist. All the gold-bearing gravel in the creeks is derived, as I have already said, not from the veins in the trachytic breccia, but from the much thicker and crystalline veins in the primary rocks.

The surface-deposit in those creeks is very rich, but, as compared with Australian and Californian gold-fields, of limited extent and depth.*

The coal beds at Coromandel occurring between strata of trachytic breccia are too thin to be of any value, and as the coal formation is absent there is no ground for hoping that a workable seam may be found.

The primary formation occurs to a more considerable extent to the eastward of Auckland, in ranges on both sides of the Wairoa river, attaining an altitude of one thousand five hundred feet above the sea, and striking from thence northwards, over Waiheki and Kawau, to the Bay of Islands. In a southerly direction they extend through the Hangawera and Taupiri ranges, across the Waikato, through the Hakari-mata and Hauturu range, parallel with the west coast, to the Mokau district, where, at Wairere, the Mokau river falls in a magnificent cascade over a lofty precipice.

The same formation occurs again in the Rangitoto mountain on the Upper Waipa, and west of Taupo lake in the Tuhua mountains. But the most extensive range of primary rocks is that which commences near Wellington, under the name of Tararua and Ruawahine, and runs in a north-easterly direction to the east shore of Taupo lake, under the name of Kaimanawa, in which rises the principal source of the Waikato, there called Tongariro river. The range continues from the shores of Taupo lake, in a north-easterly direction, to the East Cape, under the principal name of Tewhaiti. This lofty and extensive mountain range—the true backbone of the Northern Island—with peaks from six thousand to seven thousand feet, is entirely unknown. In this range the plutonic and metamorphic rocks, yet unknown in the Northern Island, may, perhaps, be found.

* Dr. Hochstetter washed a few buckets of surface-earth and gravel, at a creek pointed out by Mr. Charles Heaphy, near King's Mill, at the Kapanga. Every panful showed scales of thin gold, with small fragments of quartz streaked and studded with veins and spangles of gold. These "specimens," as they are called by diggers, show no, or very little, sign of being water-worn, but are sharp and crisp fragments, as if they had been broken up on the spot, or in the immediate vicinity. The quartz veins in the mountains should be thoroughly examined, and when once the day has come that the Coromandel gold-fields are worked, the attention of the digger should be directed as well to the hills immediately above any rich deposits as to the alluvial workings below.

Nearly all the primary ranges are covered with dense virgin forests, which render them extremely difficult of access. It must be left to the labour and enterprise of future years to discover and develope the mineral riches, the existence of which appears to be probable, not only from the geological characteristics of the country, but also from some few specimens of lead and copper-ores that have from time to time been picked up by the natives.

It is remarkable that, while one of the oldest members of the Primary formation is found so extensively in New Zealand, the later strata, as the Devonian, Carboniferous and Permian, appear to be altogether wanting; while, on the other hand, in the neighbouring continent of Australia these members of the Primary period, together with plutonic and metamorphic rocks, constitute, as far as we know, almost the principal part of the continent.

A very wide interval occurs between the primary rocks of the Northern Island and the next sedimentary strata met with. Not only the upper members of the primary series are absent, but also nearly the whole of the secondary formations. The only instance of secondary strata met with consists of very regular and highly-inclined beds of marl alternating with micaceous sandstone, extending to a thickness of more than one thousand feet—first seen on the south head of the Waikato, and afterwards met with on the western shore of Kawhia harbour.

These rocks possess great interest from the fact that they contain remarkable specimens of marine fossils, which belong exclusively to the secondary period, especially cephalopods of the genera *Ammonites* and *Belemnites*, several species of the *Belemnites* belonging to the family of the Canaticulati. These are the first specimens of those genera which have been discovered in the regions of Australasia. Both fossils have been known for centuries by our ancestors in the Old World—the ammonite as the horn of Jupiter Ammon, and the belemnite as the bolts of the God of Thunder; the latter, though now first seen in the antipodes by Europeans, have long been known to the natives of Kawhia by a much less dignified name.

Secondary rocks may probably be found in some other parts of the west coast, and occur, according to the Rev. A. G. Purchas, in the harbour of Hokianga, but everywhere are of limited superficial extent.

The Doctor next speaks of the Tertiary strata which, under very various characters, occupy a large portion of the Northern Island. The various tertiary strata are found for the most part in a horizontal position—a remarkable fact, from which we may conclude that even the numerous volcanic eruptions which took place during and after the period of their deposition had not power enough to dislocate the whole system, but merely to produce local disturbances.

The Tertiary period must here be divided into two distinct eras, which may perhaps correspond to the European Eocene and Miocene. There is an older formation which is found principally on the west coast, and in the interior on both sides of the primary ranges; and a newer one which may be called the Auckland Tertiary Formation.

It will probably be interesting to give some more minute description of the different strata of the older of these formations, as to it belongs the "Brown-Coal" seams, to the discovery of which Dr. Hochstetter is indebted for the opportunity of investigating the geology of Auckland, and on the proper working of which he believes much of the future welfare of that province depends.

The Brown-Coal formation is of very considerable extent both in the northern and middle islands of New Zealand, and is everywhere of similar character.

The Drury coal, in the Drury and Hunua districts, belongs to a very good

sort of brown-coal—to the so-called "Glanzkohle," with conchoidal fracture, instead of the existence of different series of seams, one above the other, on different levels. Dr. Hochstetter inclines much rather to the opinion that it is the same seam, disturbed in its level, which occurs at the different localities. The average thickness of the coal seam may be estimated at five or six feet.

The seam consists of three portions: the upper part a laminated coal of inferior quality, one foot ; then a band of shale, two inches; the middle part coal of a good quality, one and a-half feet ; then a band of bituminous shale, six inches ; the lowest part presenting coal of the best quality, two and a-half feet. The bituminous shale accompanying the coal contains fossil plants, principally leaves of dicotyledons. It is remarkable that no fossil ferns are found in connection with the Drury coal-beds; the more so as at another locality, on the west coast, seven miles from Waikato Heads, only fossil ferns, in a most beautiful state of preservation, are imbedded in gray argillaceous strata, alternating with sandstone and small coal-seams, probably of the same geological age as the Drury coal.

The fossil gum found in the coal is a kind of "retinite," derived from coniferous trees, perhaps related to the kauri, but it is by no means identical with the "kauri-gum," which is only found in the surface soil in those localities where there have been kauri forests. The fossil gum and kauri-gum are very different in their qualities, as the most simple experiments in their ignition will show.

The thickness of the forest and the inaccessibility of the country prevent our now ascertaining, in an exact manner, the extent of the Drury coal-field. Still the existing openings show an extent of the coal-field sufficient to encourage any company to work the coal in an extensive manner.

A company, under the name of "The Waihoihoi Mining and Coal Company," has been formed to begin the working of it.

The same kind of coal is seen again on the northern slope of Taupiri and Hakarimata range. At Kupakupa, on the left bank of the Waikato, is a beautiful seam about one hundred and fifty feet above the level of the river. The thickness of the seam there exposed is about fifteen feet; how much greater the thickness may be it is impossible to say, as the floor has never been uncovered. This is the seam to which the attention of the inhabitants of Auckland was directed several years ago by the Rev. A. G. Purchas. Several tons were at that time brought to Auckland; but owing to various circumstances, the chief of which was the native ownership, the hope of obtaining a supply from thence for Auckland was abandoned. No better, position could, however, be found for mining-purposes; and the day cannot be far distant when it will be worked to supply fuel for the steam navigation of the Waikato, the main artery of the Province of Auckland.

Dr. Hochstetter believes that a coal-field of considerable extent exists on the borders of the wide plains on both sides of the Waikato, between Taupiri and Mangatawhiri, for which district, shut in on all sides by ranges, he proposes the general geographical name of "The Lower Waikato Basin."

A third coal-field exists on the western and southern boundaries of the very fertile alluvial plains above the junction of the Waipa and Waikato, which may be distinguished as "The Middle Waikato Basin"—the future granary of the northern portion of the island.

The localities in which coal has been discovered are the following :—in the Hohinipanga range, west of Karakariki on the Waipa; near Mohoanui and Waitaiheke, in the Hauturu range on the upper branches of the Waipa; and again in the Whawharua and Parepare ranges on the northern side of Rangitoto-mountains.

These comparative analyses will show that the Drury coal is similar to the European brown coals in its three principal constituents:

	Wood.		Auckland Lignite.		Brown Coal.		Black Coal and Anthracite.	
Carbon	51·4 to	52·6	55·0 to	57·0	55·0 to	76·0	73·0 to	96·51
Oxygen	43·0	42·0	15·0	67·0	26·0	19·0	23·0	3·0
Hydrogen	6·0	5·5	4·0	13·0	4·3	2·5	5·5	0.5

Although of entirely different character, and, generally speaking, of inferior value to the older coals of the Primary formations, there is no reason why this kind of coal should not be used in New Zealand for the same purposes as a similar brown coal in various parts of Europe, particularly in Germany, where it supplies the fuel for manufactures of all kinds, for locomotives and steamers, and for domestic purposes. Dr. Hochstetter strongly recommends that any company formed for the purpose of working the coal should also establish potteries for the manufacture of earthenware. Remarkably suitable clays of every necessary variety exist in the immediate neighbourhood of the coal-fields. By the establishment of such works, the value of the coal would be made apparent to everybody, and the manufacture itself, if properly conducted, could not fail to be remunerative. It may be interesting to know that the far-famed "Bohemian porcelain" is burnt by means of brown coal, from a seam of, in some places, ninety feet thickness. While stating the uses to which brown coal may be applied, it is necessary to warn against the idea that it is suitable for steamers having to make long sea voyages. The bulky nature of the brown-coal will always prevent such steamers taking it on board when they can procure black coal. But, on the other hand, its qualities as a gas-producing coal will render it valuable as an article of export.

Of the older Tertiary strata examples are found occurring in great regularity on the west coast from Waikato to Kawhi. The lowest are argillaceous, the middle calcareous, the upper arenaceous.

The characteristics of the first clayey strata are a light grey colour, very few fossils, small crystals of iron pyrites and glauconitic grains, which give these clay-marls a similarity to the gault and green-sands of the Cretaceous formation in Europe. They are found on the eastern branches of Whaingaroa, Aotea, and Kawhia harbours.

Of greater interest and importance are the calcareous strata, consisting of tabular limestone, sometimes of a conglomerate nature, sometimes more crystalline, the whole mass of which is formed of fragments of shells, corals, and foraminifera, interspersed with perfect specimens of terebratulæ, oysters and pectens, and other shells. This limestone, when burnt, makes excellent lime, and may be wrought and polished for architectural purposes.

The beds of limestone worked by Messrs. Smith and Cooper, in the Wairoa district, belong to this formation, as do also the rich fossiliferous strata from the Waikato Heads towards Kawhia harbour.

Picturesque columnar rocks of the same nature, looking almost as if they were artificially built of tabular blocks, adorn the entrance to Whaingaroa harbour; and the romantic (limestone) scenery, and the fine caves of the Rakaunui river, a branch of Kawhia harbour, are deservedly prized by the settlers of Kawhia Harbour.

The limestone formation attains its greatest thickness (from four hundred to five hundred feet) in the Upper Waipa and Mokau district, between the Rangitoto range and the west coast. It has in this country many remarkable features.

No one can enter without admiration the stalactite caves of Tana-uri-uri, at Hangatiki, and of Parianewanewa, near the sources of the Waipa, the former haunts of the gigantic Moa.

Dr. Hochstetter says: "I went into those caves in the hope of meeting

with a rich harvest of Moa skeletons, but I was sadly disappointed. Those who had been before me in the days of Moa enthusiasm having carried off every vestige of a bone. Great, however, was my labour, and not little my satisfaction, in dragging out the headless and legless skeleton of a Moa from beneath the dust and filth of an old raupo hut. The Maories, seeing the greediness with which the 'pakehas' hunted after old Moa bones, have long since carefully collected all they could find, and deposited them in some safe hiding-place, waiting for the opportunity of exchanging them for pieces of gold and silver, showing thus how well they have learnt the lesson taught them by the example of the 'pakeha.'

The subterranean passages of the rivers in the Pehiope and Mairoa district are highly characteristic of the limestone-formation. The limestone-rocks, fissured and channelled, are penetrated by the water, and the streams run below the limestone upon the surface of the argillaceous strata, underlying the limestone. This explains the scarcity of water on the limestone plateau which divides the sources of the Waipa and Mokau rivers. The plateau is covered with a splendid growth of grass, and would form an excellent cattle run but for the deep funnel-shaped holes which everywhere abound. They are similar to the holes which occur in the limestone-downs in England, and on the Karst mountains on the shore of the Adriatic Gulf, where they are called "dolines."

The third and uppermost stratum of the older tertiary formation consists of beds of fine fossiliferous sandstone, in which quarries of good building-stone may be found. There are whole ranges parallel to the primary mountains which seem to consist of this sandstone, as, for example, the Tapua-wahine range, about two thousand feet above the level of the sea.

Without a map on a large scale, it would be useless to enter more minutely into a description of the various localities in which the different formations occur. It may, however, be mentioned that limestone and brown-coal have been found in places to the north of Auckland, in the districts from Cape Rodney to North Cape.

The horizontal beds of sandstone and marls which form the cliffs of the Waitemata, and extend in a northerly direction towards Kawau, belong to a newer tertiary formation, and, instead of coal, have only thin layers of lignite. A characteristic feature of the Auckland tertiary formation is the existence of beds of volcanic ashes, which are here and there interstratified with the ordinary tertiary layers.

The volcanic formations, from their great extent and the remarkable and beautiful phenomena connected with them, render the Northern Island of New Zealand, and especially the province of Auckland, one of the most interesting parts of the world.

Lofty trachytic peaks covered with perpetual snow, a vast number of smaller volcanic cones presenting all the varied characteristics of volcanic systems, and a long line of boiling springs, fumaroles, and solfataras, present an almost unbounded field of interest, and, at the same time, a succession of magnificent scenery.

It is only through a long series of volcanic eruptions, extending over the Tertiary and Post-Tertiary periods, that the Northern Island has attained its present form. It would be a difficult task to point out the ancient form of the antipodean Archipelago, the site of which is now occupied by the Islands of New Zealand. It is necessary, therefore, to restrict these remarks to a simple indication of the events which have given that country the form it was found to have by the South-Sea Islanders on their arrival, many centuries ago, from the Samoan group—a form in all main respects the same as is now before our eyes.

The first volcanic eruptions were submarine, consisting of vast quantities of

trachytic lava, breccia, tuff, obsidian, and pumice-stone, which, flowing over the bottom of the sea, formed an extensive submarine volcanic plateau. The volcanic action continuing, the whole mass was upheaved above the level of the sea, and new phenomena were developed. The eruptions going on in the air instead of under the sea, lofty cones of trachytic and phonolithic lava, of ashes and cinders, were gradually formed. These eruptions, breaking through the original submarine layers of trachytic lava—breccia and tuff, raised them, and left them as we now find them, forming a more or less regular belt round the central cones, and having a slight inclination from the centre outwards. These belts I shall have occasion to refer to under the name of "tuff-craters," or "cones of tuffs," or "craters of elevation." In the course of time the volcanic action decreased, and we must now imagine that tremendous earthquakes occurred; that parts of the newly-formed crust gave way and fell in, forming vast chasms and fissures, which are now occupied by the lakes, hot-springs, and solfataras.

Thus we now find in the central part of the Northern Island an extensive volcanic plateau of an elevation of two thousand feet, from which rise two gigantic mountains, Tongariro and Ruapahu. They are surrounded by many smaller cones, as Pihanga, Kakaramea, Kaharua, Rangitukua, Puke Onake, Hauhanga. The natives have well named these latter, "the wives and children of the the two giants Tongariro and Ruapahu;" and they have a legend to the effect that a third giant, named Taranaki, formerly stood near these two, but quarrelling with his companions about their wives, was worsted in combat, and forced to fly to the west coast, where he now stands in solitary grandeur, the magnificent snow capped beacon of Mount Egmont (eight thousand two hundred and seventy feet). These are the three principal trachytic cones of the Northern Island.

By far the grandest and loftiest of the three is Ruapahu, whose truncated cone, standing on a basis of about twenty-five miles in diameter, attains a height of nine thousand to ten thousand feet above the level of the sea, about three thousand feet of which is covered with glaciers and perpetual snow. Ruapahu, like Taranaki, is extinct. Tongariro alone can be said to be active. Dr. Hochstetter distinguished five craters on Tongariro, three of which are, to a certain extent, active. Steam is always issuing from them, and the natives state that from the principal crater, called Ngauruhoe, on the top of the highest cone of eruption (seven thousand five hundred feet), occasional eruptions of black ashes and dust take place, accompanied with loud subterranean noises. It may be remarked that the shape of the cone is changing, the western side, for instance, having, during the great earthquake at Wellington in 1854, fallen in, so that the interior of the crater is now visible from the higher points in the Tuhua district on the Upper Whanganui. The remarkable fact, that snow does not rest upon some of the upper points of the Tongariro system, while the lower ones are covered all the winter through, shows that those parts are of a high temperature.

There is an interesting account of an ascent of the highest cone of eruption by Mr. H. Dyson, communicated to the "New Zealander," 1851, by A. S. Thomson, M.D. Mr. Dyson, in 1851, and Mr. Bidwell, in 1839, are the only Europeans who have ascended the highest cone of Tongariro.

The second active crater of the Tongariro system, at the top of a lower cone north of Ngauruhoe, is called Ketetahi. According to the natives the first eruption of this crater took place simultaneously with the Wellington earthquake of 1854. From Taupo lake Dr. Hochstetter saw large and dense volumes of steam, larger than those from Ngauruhoe, emerging from the Ketetahi crater. The third active point on the Tongariro system is a great solfatara on the north-western slope of the range. The hot sulphurous springs of that

solfatara are often visited by the natives on account of the relief they experience in respect to their cutaneous diseases.

A grand impression is made upon the traveller by those two magnificent volcanic cones, Ruapahu, shining with the brilliancy of perpetual snow, Tongariro, with its black cinder-cone capped with a rising cloud of white steam: the two majestic mountains standing side by side upon a barren desert of pumice, called by the natives One-tapu, and the whole reflected as by a mirror by the waters of Lake Taupo.

Lake Taupo is twenty-two English miles long in the direction from Terapa to Tapuaeharuru, and sixteen broad. It is surrounded by elevated pumice-stone plateaus, above two thousand feet above the sea, and seven hundred feet above the lake. The Waikato river, taking its rise from Tongariro, flows through the lake, traversing the pumice-stone plateau on either side. In accordance with the names already proposed for the middle and lower Waikato Plains, the Taupo country will form the Upper Waikato Basin.

It is one of the most characteristic features in the structure of the Northern Island, that from the shores of Taupo Lake an almost level pumice-stone plain, called Kaingaroa Plain, stretches at the foot of the East Cape range, with a very gradual descent to the coast between Whakatane and Matata. A plain which, though now presenting a sterile appearance, will, I hope, at no distant day, be converted into fine grassy land, capable of supporting large flocks of sheep.

In a similar way, a higher volcanic plateau, consisting of trachytic tuff and breccia, and various other volcanic rocks, stretches in a more northerly direction to the east coast, between Maketu and Tauranga, the farthest extremities of which reach even to the Auckland district. On one side of Hauraki Gulf, the Coromandel range is covered with trachytic breccia, and again, on the west coast, the same rocks form the coast-range from Manukau to Kaipara. This extensive plateau is intersected by many deep valleys, the sides of which are characterized by a succession of remarkable terraces. The same plateau is also broken in many places by more or less regular trachytic cones, from one thousand to three thousand feet high. If we take a wider view of the geological features and the physical outline of these just described high plains and plateaus consisting of regular layers of trachytic rocks, breccia, and tuff, we shall find that the steep cones of Ruapaho and Tongariro rise from the centre of a vast tuff-cone of extremely gradual inclination, the basis of which occupies the whole country from shore to shore—from east to west—having a diameter of one hundred sea-miles, and forming the largest cone of tuffs, or in other words the largest crater of elevation in the whole world.

Intimately connected with the described volcanic phenomena of the active and extinct volcanic mountains are the solfataras, fumaroles, and hot springs. They are found in a long series, stretching across the country in a north-north-east direction, from the active crater Ngauruhoe in the Tongariro system, to the active crater of White Island (Whakari), occupying the chasms and fissures already referred to.

There is only one other place in the world in which such a number of hot-springs are found that have periodical outbursts of boiling water, that is in Iceland, the well known geysirs of which are of precisely similar character to those in New Zealand. Although there may be no single intermittent spring in New Zealand of equal magnitude with the great geysir in Iceland, yet in the extent of country in which these springs occur, in the immense number of them, and in the beauty and extent of the siliceous incrustations and deposits, New Zealand far exceeds Iceland.

On the southern extremity of Taupo lake, at Tokanû, is Pirori, an intermittent fountain of boiling water, two feet in diameter, sometimes reaching a height of more than forty feet. On the opposite side of Taupo, at the northern

extremity of the lake, hot-springs again are met with, and with a river of warm water called Waipahihi, which, rising in the extinct volcanic cone of Tauhara, falls, in a vapour-crowned cascade, into Taupo. Descending from Taupo by the outlet of the Waikato, on the left bank, in the midst of a great number of pools of boiling mud, is a fumarole called Karapiti, an enormous jet of high-pressure steam, escaping with such force as to produce a sound like letting-off the steam from huge boilers, and to eject to a great height sticks, or the like, thrown in by the curious traveller. On the right bank is the fumarole of similar character, called Parakiri. About twenty-five miles below the outlet of the Waikato from Taupo, at Orakei-korako, both banks of the rapidly-flowing river are perforated, in more than a hundred different places, by fumaroles and boiling-springs, mostly intermittent. Temimi-a-Homaiterangi, the principal geysir, throws up its large column of boiling water at intervals of about two hours to a height from twenty to thirty feet. An immense volume of steam succeeds each jet, and the water then suddenly sinks into the basin.

At Orakei-korako the line of hot-springs crosses the Waikato, and continues along the foot of the very remarkable Pairoa range on the eastern side of the Waikato. The almost perpendicular western side of this range is caused by an immense "fault" in the volcanic plateau, corresponding to a deep fissure in the earth-crust from which sulphurous acid, sulphuretted hydrogen, sulphur and steam are continually escaping, while huge bubbles of boiling ash-coloured mud rise to the surface.

From the same range the warm-water river Waikite takes its origin. On both sides are deep pools of boiling water, on the margins of which we discovered most beautiful ferns, hitherto unknown, one species belonging to the genus *Nephrolepis*, the other to the genus *Goneopteris*. These ferns are remarkable not only for their elegance, but also from the peculiar circumstances under which they exist, as they are always surrounded by an atmosphere of steam.

We now come to the well known Rotomahana, the most wonderful of all the wonders of the hot-spring district of New Zealand. Whoever has once had the happiness to look into the blue eyes of Otukapuarangi and Te Tarata can never forget their charms; and whoever has stood beside the boiling surf of the Ngahapu basin will always retain a vivid impression of its terrors. The terraces of siliceous deposit on the shores of Rotomahana are unequalled in the world, nor is there anything that even bears any resemblance to them.

On the Rotorua lake the intermittent boiling springs of Whaka-rewarewa are the most interesting. Waikite, the principal "ngawha," issues from the top of a siliceous cone some twenty feet high, surrounded by several smaller geysirs, mud-pools, and solfataras. At intervals, sometimes extending to many months, all these "ngawhas" begin to play together, and form a scene which must be most wonderful and beautiful. The hot-springs of Ohinemutu form agreeable bathing-places, the fame of which is already established. The last in the line are the great solfataras on the pumice-stone plateau between Rotorua and Rotoiti, such as Tikitere and Ruahine.

All the waters of these springs are derived from atmospheric moisture, which, falling on the high volcanic plateau, permeates the surface and sinks into fissures. Taupo, the axis of which corresponds with the line of the hot springs, may also be considered as a vast reservoir, from which the lower springs are supplied. The water, sinking into the fissures, becomes heated by the still-existing volcanic fires. High-pressure steam is thus generated, which, together with the volcanic gases, decompose the trachytic rocks. The soluble substances are thus removed by the water, which is forced up, by the expansive force of the steam and by hydrostatic pressure, in the shape of boiling springs. The insoluble substances form a residuum of white or red fumarole clay, of which the hills at Terapa round Rotamahana and the Pairoa consist.

All the New Zealand hot-springs, like those of Iceland, abound in silica, and are to be divided into two distinct classes, the one alkaline, and the other acid. To the latter belong the solfataras, characterized by deposits of sulphur, and as never forming intermittent fountains. All the intermittent springs belong to the alkaline class, in which are also included the most of the ordinary boiling springs. Sulphurets of sodium and potassium, and carbonates of potash and soda are the solvents of the silica, which, on the cooling and evaporation of the water, is deposited in such quantities as to form a striking characteristic in the appearance of these springs.

To enter more deeply into the theory of these phenomena would be out of place here. It may be, however, well to mention that numerous facts prove that the action which gives rise to the hot-springs is slowly diminishing.

Ere long these hot springs will probably be visited by many travellers, not only for the sake of their beauty and interest, but also for the medicinal virtues they have been proved to possess. Already many Europeans have bathed in, and derived benefit from, the warm waters at Orakei-korako and Rotomahana.

There is an interesting legend current among the natives in reference to the origin of these hot springs. The legend, as told by Te Heuheu, the great chief on the Taupo lake, is the following:—"The great chief Ngatiroirangi, after his arrival at Maketu at the time of the immigration of the Maories from Hawaiki, set off with his slave Ngauruhoe to visit the interior, and, in order to obtain a better view of the country, he ascended the highest peak of the Tongariro. Here they suffered severely from cold, and the chief shouted to his sister on Whakari (White Island) to send him some fire. This they did. They sent on the sacred fire they brought from Hawaika, by the taniwhas Pupu and Ta Haeata, through a subterranean passage to the top of Tongariro. The fire arrived just in time to save the life of the chief, but poor Ngauruhoe was dead when the chief turned to give him the fire. On this account the hole through which the fire made its appearance—the active crater of Tongariro—is called to this day by the name of the slave Ngauruhoe; and the sacred fire still burns within the whole underground passage along which it was carried from Whakari to Tongariro."

This legend affords a remarkable instance of the accurate observation of the natives, who have thus indicated the true line of the chief volcanic action in this island.

Having described the older and more extensive volcanic phenomena of the interior, Dr. Hochstetter proceeded to notice the later phenomena of volcanic action in the immediate neighbourhood of Auckland.

The isthmus of Auckland is completely perforated by volcanic action, and presents a large number of true volcanic hills, which, although extinct and of small size, are perfect models of volcanic mountains. These hills, once the funnels out of which torrents of burning lava were vomited forth, and afterwards the strongholds of savage cannibals, are now the ornaments of a happy land, the home of peaceful settlers, whose fruitful gardens and smiling fields derive their fertility from the substances long ago thrown up from the fiery bowels of the earth.

Dr. Hochstetter's geological map of the Auckland district shows no less than sixty points of volcanic eruption within a radius of ten miles; the variety of which, together with the regularity of their formations, gives very great interest to this neighbourhood. The newer volcanic hills round Auckland are distinguished from the older ones in the interior, not only by their age, but by the different character of their lava, the older being trachytic, while the Auckland are all basaltic. The difference between trachyte and basalt consists in the minerals of which the rocks are composed. Trachyte is composed of a mixture of glassy felspar (sanidin) and hornblende: obsidian and pumice-stone are

the usual concomitants of trachytic lava. Basalt consists of a minutely crystalline mass of felspar mixed with augite; an admixture of greenish grains of olivine is characteristic of basalt.

In order to gain a clear idea of the history of the Auckland volcanos, we must suppose that before the period in which the Auckland isthmus was slowly raised above the level of the sea, a submarine volcanic action was already going on. The products of this submarine action are regular beds of volcanic ashes, which form highly interesting circular basins with strata always inclining from within, outwards. Several striking examples can be mentioned, as the Pupuki Lake on the north shore, Orakei Bay in the Waitemata; Geddes' Basin (Hopua) at Onehunga, and the tidal basin (Waimagoia) at Panmure. Pupuki Lake, believed to be bottomless, has been ascertained by Captain Burgess to be only twenty-eight fathoms. The excellence of the soil of Onehunga and Otahuhu is owing to the abundance of such formations, the decomposed strata of which form the richest soil that can be met with. It is curious to observe how the shrewder amongst the settlers, without any geological knowledge, have picked out these tuff-craters for themselves, while those with less acute powers of observation have quietly sat down upon the cold tertiary clays.

After the submarine formation of the tuff-craters, the volcanic action continuing, the isthmus of Auckland was slowly raised above the sea, and then the more recent eruptions took place by which the cones of scoria, like Mount Eden, Mount Wellington, One Tree Hill, Mount Smart, Mount Albert, and Rangitoto, were formed, and great outflowings of lava took place. Many peculiar circumstances, however, prove that those mountains have not been burning all simultaneously, for it can easily be observed that some lava-streams are of an older date than others. In general the scoria-cones rise from the centre of the tuff-craters (Three Kings, Waitomokia, Pigeon Hill near Howick); but occasionally, as in the instance of Mount Wellington, they break through their margins.

The crater system of Mount Wellington is one of the most interesting in this neighbourhood. There are craters and cones of evidently different ages. The result of the earliest submarine eruptions is a tuff-crater. The Panmure-road passes through the tuff-crater, and the cutting through its brim exhibits beautifully the characteristic outward-inclination of the beds of ashes, elevated from their former horizontal levels by the eruptions, which threw up the two minor crater-cones south of the road, one of which is now cut into by a quarry. After a comparatively long period of quiescence, there arose from the margin of the first crater system the great scoria-cone, Mount Wellington, from the three craters of which large streams of basaltic lava flowed out in a westerly direction, extending north and south along the existing valleys of the country, one stream flowing into the old tuff-crater, and spreading round the bases of the smaller crater-cones. The larger masses of these streams flowed in a south-westerly direction towards the Manukau, coming into contact with the older and long-before hardened lava-streams of One Tree Hill. The traveller on the Great South Road will observe about one mile east of the "Harp Inn," the peculiar difference in the colour on the road, suddenly changing from red to black, where the road leaves the older and more decomposed lava-streams of Mount Wellington. The farmers have been able to avail themselves of the the decomposed lava-surface, which is now beautifully grass-covered, but not of the stone-field of the newer streams from Mount Wellington and Mount Smart.

The caves at the Three Kings, Pukaki, Mount Smart, Mount Wellington, &c., are the result of great bubbles in the lava-streams, occasioned by the generation of gases and vapour as the hot masses rolled onward over marshy plains. These bubbles broke down on their thinnest part—the roof; hence the way into the caves is always directly downward.

Examples of every gradation may be seen, from the simple tuff-crater without any cone, to those which are entirely filled up by the scoria-cones. Especially interesting are those which may be said to represent the middle state, in which there is a small cone standing like an island in a large tuff-crater, and surrounded by either water or swamp. Perhaps the most perfect specimens of this kind occur at Otahuhu, and near Captain Haultain's estate. Auckland itself is but over the centre of an old tuff-crater, from which fiery streams once issued, and which has thrown out its ashes towards the hill on which the barracks stand. In order to account for their various shapes, it must be borne in mind that the cones of scoria were once higher, but on the cessation of volcanic action they sunk down in cooling, and some have entirely disappeared.

That the Auckland volcanos were, in the true sense of the word, "burning mountains," is proved not only by the lava-streams, which are immense in comparison to the size of the cones, but also from the pear-shaped volcanic bombs which, ejected from the mountain in a fluid state, have received their shape from their rotary motion through the air. That their eruptions have been of comparatively recent date, is shown by the ashes that everywhere form the surface, and from the lava-streams having taken the course of the existing valleys. This is beautifully exemplified by the probably simultaneous lava-streams of Mount Eden, the Three Kings, and Mount Albert, which, flowing through a contracted valley, meet altogether on the Great North Road, and form one large stream to the shore of the Waitemata. But many thousand years may have passed since Rangitoto, which is probably the most recent of the Auckland volcanos, was in an active state.

Many subjects of interest were passed over by Dr. Hochstetter with only casual remarks, such as the quaternary formation in the Drury, Papakura, and Waiuku flats; the basaltic boulder formation; the alluvial formations in the middle and lower Waikato Basin, and other places; and the changes which are now going on.

The materials accumulated during his six month's sojourn in New Zealand will require, he states, several years of labour to prepare for publication; but we are led to expect valuable results whenever his work is completed.

Ancient Canoes.—Dear Sir,—There being now reason to believe that the British Isles were tenanted by human beings who probably crossed over from the great continent of Europe, the question of the antiquities of canoes becomes highly interesting. Very primitive indeed are these ancient canoes which have hitherto been found—simply a part of a trunk of a tree split and hollowed out with rudely formed adzes of flint, such as have been found in the crannoges* in Ireland.

Seventeen such canoes have been found in the strata formed by the river Clyde; for an account of which see the lecture on Geology, given by his Grace the Duke of Argyll, before the members of the Glasgow Athenæum, in January of last year.

From the fact of the canoes being found twenty feet below the surface, there can be no doubt that they were entombed at a very remote period, for it must have required a long time for those canoes to have become covered to that extent with the sand and gravel brought down by the river, in the waters of which thay had sunk. Numbers of similar instances might be adduced of canoes being found at considerable depths.

Of the canoes above alluded to, one is stated to have been found in digging

* See the "Catalogue of Antiquities of Stone, &c., in the Royal Irish Academy." Dublin M. H. Gill.

the foundations of St. Enoch's church, Glasgow; another at the "Tontine-buildings," at the Cross;" and a third in digging the foundations of the new prison. In the British Museum, the Museum of the Yorkshire Philosophical Society at York, and in the collections of other societies, at Edinburgh, Glasgow, Newcastle, &c., will be found other examples.—Yours, EDWARD TINDALL, Bridlington.

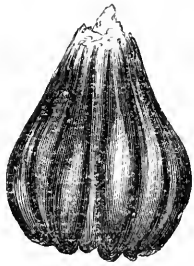
VEGETABLE FOSSILS IN FLINT, &c.—Will you be so kind as to inform me in your "Notes and Queries" whether any vegetable matter has yet been discovered in flint? I have been anxiously reading any articles in the "GEOLOGIST" on fossils from flints, but find no mention of such. My regards were particularly directed to the subject, by discovering embedded in red flint what appears to be a portion of *Corallina officinalis,* as a living specimen would be called, with this difference, that the stem seems formed of minute threads jointed at intervals. The fossil, though small, is quite distinct, and the terminal ceramidia look like little pearls. The surface of the flint in the immediate neighbourhood of the coralline, if it be such, is of a chocolate colour.

I shall be much obliged if you will have the goodness to direct me to some not expensive work on the limestone and lower slate formations of Ireland. —Very truly yours, A. de S. M.

The flints of the chalk occasionally contain fragments of fossil wood, and more frequently the spores of Algals, the so-called *Spiniferites* of Mantell's "Medals." Other vegetable fossils are rare in the flints. Possibly the minute Corallina-like object in the flint referred to may be a *Nodosaria,* one of the elongated beaded Foraminifera. We cannot call to mind any work treating of the limestone and slates of Ireland.

EVIDENCES OF ANCIENT ICE-ACTION NEAR LIVERPOOL.—DEAR SIR,—The new red sandstone in this neighbourhood is usually covered with deposits of hard clay, containing rounded stones of all sizes, from that of a pea to those five or six feet in circumference; in some cases they are scratched and polished. There are also beds of sand and gravel containing shells, which are generally beneath the clay. The whole of these deposits are referred to the "boulder-clay," or "northern drift." It is assumed that the clay, sand, gravel, or boulder-stones were all dropped from melting icebergs as they descended from more northern latitudes. I am not aware that we have hitherto had any other evidence in this district than that afforded by the boulders, though that evidence is very conclusive. During the month of May last my attention was called to the subject by indications of ice-grooves and furrows on the high ground between Parkhill-road and the Dingle. The sandstone-rock belongs to the conglomerate-beds of the bunter-sandstone. The strata dip ten degrees to the east. The striated surface has been covered by nine feet of boulder-clay, part of which was removed some years ago for brickmaking. One specimen exhibited the strongly marked parallel lines and deep grooves which extended across it. The surface from which it was obtained dips five degrees to the north-east. The direction of the lines is north-west by north, or more correctly, forty-two degrees west of north, allowing twenty-four degrees for variation. About ten yards were at first visible; but, by employing a labourer to clear away some of the clay, at least twenty square yards have been observed, and no doubt the same appearances extend over a considerable extent of surface beneath the boulder-clay. If this worn surface resulted from the action of ice, it must have been from the grounding of icebergs as they passed over the portion of rock upon which it is found. In the valley beyond Eastham the boulder-clay contains many fragments of red sandstone, which seem to have been derived from the high land already alluded to, and afford further indications as to the direction of the prevailing currents of the glacial sea.—GEO. H. MORTON, F.G.S., Liverpool.

Fossil Fruit from Upper Coal Measures, near Bolton.—Dear Sir,—Having noticed your kindness in inserting any remark upon phenomena which may have passed under the notice of your readers, I take the liberty of making the following. The enclosed is a fruit I have obtained from a quarry in the upper coal measures, near Bolton. It occurred along with masses of *Trigonocarpum oliviforme*, *Noeggerathia*, &c., together with *Calamites*, *Sigillariæ*, *Lepidodendron*, and *Calmia*, &c.; and the upper flag shales contain numerous impressions of ferns, chiefly *Pecopteris lonchitica*, *Neuropteris*, &c. The large



Lign. 1.—Large Fruit, from the Upper Coal Measures, near Bolton.

fruit is now in the possession of Mr. Binney, of Manchester: it has six lobes, which ascend from the base and meet at the summit, and it is larger than the usual *Trigonocarpum*. Its appearance very much resembles the fruit of the Zamia, figured in vol. i. of Mantell's "Medals of Creation." The smaller fruit

Lign. 2.—Small Fruit, from the Upper Coal Measures, near Bolton. Lign. 3.—Section of Small Fruit.

is about the size of a large pea; it is much like the larger, but its lobes are not so rounded; it appears to be the young of the other. If any of your readers have met with such an one, and will let me know, or if you will offer any remarks, it will oblige yours, John Taylor, Levenshulme.

Geology of Malta.—Sir,—Will you furnish me with some information on the subject of the deposits in the island of Gozo, off Malta?

The islands of Malta and Gozo consist of Tertiary rocks. These were described in 1843 by Captain Spratt, who with Lord Ducie has since prepared a geological map of these islands. In the Proceedings of the Geological Society, vol. iv., p. 225, &c., is an account of the beds found in the islands, namely, 1st and uppermost, coral-limestone; 2, yellow sandstone and blue clay; 3, freestone; and 4, semi-crystalline limestone. These strata lie for the most part horizontally, though faulted and crumpled in some places. In the Benjemma Hills the four groups of beds have a thickness of about six hundred feet. Professor E. Forbes' report upon the fossils accompanied Captain Spratt's memoir. Since then Dr. Wright has figured and described the fossil

Echinoderms of Malta in the Annals of Natural History, 2nd series, vol. xv., p. 101, &c.

Echinoderms are abundant in beds Nos. 1, 2, and 3, and are found also in No. 4. Sharks have left their teeth abundantly in No. 2; and remains of other fishes are frequent in No. 3.

NEW GEOLOGICAL WORKS.—Can you tell me whether anything like a complete list of all the works on geology published during the last year can be procured? Such a list would of course include new editions of old books, such as the last of "Siluria," Page's "Handbook," &c. And then with reference to the "works of art in the drift;" do you know of any résumé or analysis of this question? It would be exceedingly interesting to have the whole evidence collected, in order that one might study and compare the various hypotheses at a glance, so to speak.—H. D.

With respect to works of art in the drift, such a work is in contemplation by the editor of this magazine. Bent's Monthly Literary Advertiser is supposed to give a list of all new English books and new editions. We shall give this topic further consideration, as to whether we can render the pages of this magazine useful in this respect. No résumé of the memoirs, papers, notes, discourses, lectures, letters, &c., about the flints is yet made.

PRESERVATION OF COAL PLANTS IN CABINETS.—SIR,—I have some specimens of coal shale, which as usual bear upon their respective surfaces impressions of Ferns, Calamites, &c. Several of the impressions being rather indistinct, I wish, if possible, to render them more apparent, but in such a manner as not to injure them in any way. If I mistake not, I have somewhere seen it remarked that this object may be accomplished by gently brushing over the surface a weak solution of Canada balsam dissolved in turpentine; but as I am doubtful as to whether such be the case, I have ventured to refer myself to you for the desired information.—Yours, &c., AMATOR NATURÆ.

Coal plants are very commonly much injured by collectors themselves, by being washed in water. Specimens will of course get dusty in the cabinet, and recourse is naturally had to water for cleansing them. Water is also frequently applied to heighten the contrast of their dark coally substance in ordinary examinations, but the process of wetting is always ruinous to the specimens. Appreciating the value of a proper means of preserving coal-plants, we have submitted our correspondent's question to our friend, Mr. S. P. Wood ward, of the British Museum, who tells us that he finds it "necessary to varnish, in some way, the coal-shale plants, both for the purpose of making them more distinct at a little distance, and also to enable them to be sponged when they get dusty.

"I have seen fossils varnished with Canada balsam at the Geological Society, some years ago, but it never appeared to answer for any length of time. The balsam got soft in hot weather; dust adhered to it; and after a time it was always opaque.

"I am now trying some very thin and pellucid white lac varnish, of Rowney's, which is soluble in spirits of wine. I usually endeavour to apply it the fossil only, and not to the matrix; and keep it so much diluted as not to make the surface shine more than I can possibly help. This varnish is also useful for protecting one part of a specimen while another part is being subjected to the action of wet for the purpose of cleaning it."

GEOLOGY OF CORNWALL.—SIR,—As I intend visiting Cornwall this summer, I should feel much obliged for any information you could give me through the "GEOLOGIST" as to the nature of the strata in that county, more particularly near Truro, or on the coast near the "Deadman" and "Gull" rocks, or "Gerran's Bay," and what fossils are generally found there.—Yours, &c., DELTA.

The rocks of Cornwall are chiefly slaty schists, termed "killas," and granite,

with veins of granite and porphyry, termed "elvans," &c. In the valleys towards the sea are often thick accumulations of gravel and other alluvial matters, with peaty deposits, from which stream-tin is obtained. Round about Truro the schistose rocks prevail. The Deadman is composed of slate-rock, supposed to be of Lower Silurian age, which reaches up to Pentuan, and yields a few fossils at Great Peraver, north of Gorran Haven. The quartz-rock of the Great Carn yields also a few fossils, and some have been found at Porth Caerhays. The fossils are chiefly Orthis and Trilobites.

REVIEWS.

Map of Skipton. By T. Curley, C.E., F.G.S. 1860.

We have on a former occasion noticed one of Mr. Curley's local maps, and we are glad to find that he continues to append sections and details of geological phenomena exposed in the works of which he has the direction. The present map has been executed for the local Board of Health of Skipton; and shows the lines of the new sewers and the position of the new water reservoir and filter beds. The principal geological section given is along the line of the main sewer, through the Castle to Storem's Lathe, showing the carboniferous limestone with its anticlinal axis and the superficial gravels, sands, and alluvial deposits.

Amongst the numerous other sections exposed in the works in various other streets and roads, we notice the occurrence of mammalian bones in peat, below gravel, in that of Water-street; of a shell-marl containing *Physa fontanis* in that of Thanet-street; and a gravel containing boulders, some as much as three and a-quarter tons in weight, in that of Newmarket-street.

The map is very nicely and carefully executed; and the geological details, from their reliableness, render it a valuable record of the local stratigraphical conditions.

A Comparative View of the Human and Animal Frame. By B. Waterhouse Hawkins, F.L.S., F.G.S. London: Chapman and Hall. 1860.

The object of this work is to give a comparative view of the variations in form of the bony skeleton or framework of those animals most frequently required by the artist, designer, or ornamentist; and most admirably, by judicious arrangement and skilfulness of delineation is this end attained. Whether we wish to compare vertebral columns, ribs, arms and fore-limbs, legs and hind-limbs, or to study any individual or particular bones, in these plates we have at once not only faithful portraits of the objects, but we find the attitudes of the figures so thoughtfully posed, that we can carry the comparison at once even to the different actions these bones or parts are subjected to in the different animals by similar movements. They show, too, more completely than any plates we can remember to have seen, the true archetypal plan of the vertebrate skeleton and the subservient modifications it has undergone in its adaptation to the wants and requirements of the various grades and classes of animals.

THE GEOLOGIST.

JUNE, 1860.

GEOLOGICAL LOCALITIES.—NO. I.

FOLKESTONE.

By S. J. Mackie, F.G.S., F.S.A.

(Continued from page 131.)

Where now is that great funereal mass? Where now that two thousand feet of ocean mud and sand? All round the rim of the great Wealden area the basset-edges of that thick mass crop out, bearing on their cliff-like downs patches of red loam, gravel and round flint-pebbles—remnants that mark the ravages of time and physical forces upon the rock-beds of yet another age, in which that great Cretaceous mass was slowly raised, bearing as it were on its shoulders the ever-forming ooze, filled with the relics of other intervening forms of life that reigned in that vast interval between the Secondary period and our own.

The story, then, is not half told; and we must not pause at the simple piling by the tides and sea-currents of the more than thousand feet of greensand, gault, and chalk, and the Tertiary sands and clays on these, but we must read on in the record-book that Nature keeps, and glean other facts and other scenes from its stony pages.

Slowly was the great Cretaceous mass heaved by some internal power into a giant dome, some forty miles across. Slowly as the intumescence of this vast mound increased and raised the upper beds, the waves of the ever-active sea cut them into cliffs, and sliced

them off, carrying away the debris to form the Tertiary mud and sands, which in turn—uplifted, too, with the expanding ground—were also partly sliced away, leaving the patches and remnants we have observed upon the summits of those chalk downs, which record the first act in the long period of denudation associated with the uprise of the Wealden tract. Slowly in this way did the sea do its antagonistic work, until the inner domes of gault and greensand were cut down to nearly level plains encircling one and another round the central Wealden beds, which, like an island, stood out last in the midst.

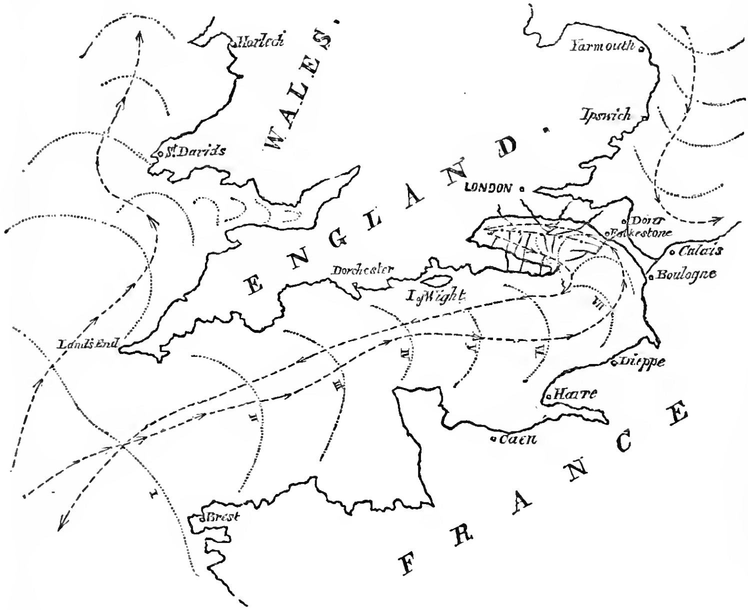
Nor is the story ended now. England and France were then united lands; no "narrow straight" separated two nations of emulative men, but the hairy mammoth, the giant elk, the thick-skinned hippopotamus, and other of the great beasts of that marvellous age of gigantic forms which preceded and joined on to the age of man the ages of the irrevocable past wandered across and lived and bred in the forests, caves, or marshes of our land.

Slowly as the intumescence proceeded, there opened out wider and wider a long fracture through the uprising land, up which the sea washed daily and nightly, with high swelling tides, that, pent up by the cliff-walls of the crack, eddied back at ebb with monstrous force, and carved out at either end the triangular edentations which still form the openings of the British Channel. Sweeping round in their eddyings as restrained by the ridge of land that formed the barrier to their onward passage, these pent-up tides scoured the Wealden plains, and strewed the bases of the downs with half-worn flints and gravel. To explain this more fully I have drawn a rough sketch of the English Channel, with the narrow neck of land which may be presumed to have existed there during at least the early part of the Pleistocene age.

We all know that the great tidal wave striking the land at the Lizard Point, in Cornwall, parts in two, or bifurcates, one tide rushing up the Channel, the other swinging round the whole extent of the coasts of Wales, Scotland, and the East of England, until it meets and collapses with the Channel tide, off Pegwell Bay.

In those geologic times to which we have referred, the narrow isthmus which stretched across from Folkestone to Boulogne barred the

onward progress of the waters; the flood-tide striking against which would bend over to one side, as indicated by the direction-arrows in the lignograph, until the time of ebb, when it would flow out with a strong current, carrying with it the debris, and thus the cause of the



Lign. 19.—Theoretical Map of the Action of the Channel Tides in the Denudation of the Wealden Area.

The outlines of England and France have been adopted as they are now delineated on ordinary maps, and no attempt at restoration has been made. At the "peninsula" period referred to the channel must have been narrower; but the outlines of the coast would probably have so nearly approximated to the present coast-lines as to render them sufficiently accurate for the elucidation of our theoretical speculation. The dotted curves indicate the hourly progress of the tidal wave; the interrupted lines with occasional arrows show the chief direction and force of the tidal stream in flowing and ebbing, by which the denudation of the Weald is presumed to have been effected. The existing coast-line of the Wealden area, the Boulogne coast, and the cliffs of Dover and Calais are indicated by faint shaded outlines, as are also the river-valleys, or cross-fractures of the Weald district, the central ridge of which, or axis of elevation, is shown by the line composed of alternate bars and dots.

clean surface of the Weald and the general absence in the few superficial deposits of any organic remains, the denudation being a tidal one.

The cross-fracture valleys on the south side of the Wealden anticlinal, or central ridge of elevation, would have afforded numerous openings on the English side of the channel-crack, up which the pent tide would have poured, and hence the reason why the greater denu-

dation of the Wealden area than of the chalk and other cretaceous rocks on the French, or more solid coast.

Worn by the incessant beating of the waves and rushing of the tides, the narrow isthmus, stretching from Folkestone to Boulogne, that formed the last connecting link was broken through, and the Channel tidal-wave passed on to meet its brother-wave, which, parted from it at the Lizard Point, had swept round the British Isles to face it again in the "narrow sea." The form and direction of this old channel-crack may even now be traced on any nautical map by a pencil line run over the marks of greatest depths, as noted in fathoms for the sailor's guidance; and the degraded shoal-ridge of the old isthmus may in like manner be perceived by the shallowness of the soundings, noted in like manner.

The first evidences of the former connection of our island with the continent of Europe were suggested by an old author on British antiquities, one Richard Verstegan. In his fourth chapter Verstegan treats of the "Ile of Albion," and "how it is shown to have beene continent, or firme land with Gallia, now named France, since the floud of Noah." After discussing the various contentions as to the origin of the name Britaine, recapitulating the fabulous narrations about King Brut, and giving his opinions on the ancestry of Britons, he proceeds to the performance of his promise in showing Albion "anciently to have beene firme lande with Gallia."

His notions of the first conditions of land and sea are very primitive, and highly tinctured with the ancient diluvial doctrines, and of course Verstegan goes back to the beginning, as all authors of his age are fond of doing so. Antiquaries of that day attempted to trace pedigrees back to Adam, and have been well characatured by Butler in his "Hudibras" for their pains; and Verstegan, the incipient geologist, goes back to the first division of the waters from the dry land, and argues as the waters were gathered together in one place, "so consequently there were no islands before the flood of Noah."

His observations, however, on the ancient connection of the lands on either side of the Channel are acute and perspicuous.

"That our Ile of Albion hath bin continent with Gallia," says he, "hath beene the opinion of divers, as of Antonius Volseus, Dominicus Marius Niger, Servius Honoratus, the French poet Bartas, our

countriemen, M. John Twine, and M. Doctor Richard White, with sundrie others; but these authors, following the opinion one of the other, are rather content to thinke it sometime so to have bin than to labour to find out by sundry pregnant reasons that so it was indeed.

"The first appearance to move likelihood of this thing is the neernes of land betweene England and France—to use the modern names of both countries—that is, from the clifs of Dover unto the like cliffs lying betweene Calis and Bullin, for from Dover to Calis is not the neerest land, nor yet are the soils alike; the shore of Dover appearing unto the saylers high and chalkie, and the shore of Calis low and altogether sandie, and in like manner the English shore towards Sandwich, which is more directly over against Calis than Dover is, also doth.

"These clifs on either side the sea, lying just opposite the one unto the other, both of one substance, that is, of chalke and flint, the sides of both towards the sea, plainely appearing to bee broken off from some more of the same stuffe, or matter that it hath sometime by nature been fastened unto; the length of the said clifs along the sea-shore being on the one side answerable in effect to the length of the verie like on the other side, and the distance between both, as some skilful saylers report, not exceeding twenty-four English miles, are all great arguments to prove a conjunction in time long past to have beene betweene these two countries, whereby men did passe on drie land from the one unto the other, as it were over a bridge or isthmus of land, being altogether of chalke and flint, and containing in length about the number of miles before specified, and in bredth some sixe English miles or thereabouts, whereby our countrie was then no iland, but peninsula, being thus fixed on to the maine continent of the world."

In the quaint sententious language of this extract, so characteristic of the style adopted by authors of the early part of the seventeenth century, there are many striking truths which the judgment of the reader will at once perceive.

Desmarest, in 1753, in his memorable paper, read before the Société d'Emulation of Amiens, repeated the evidences previously brought forward by Verstegan, but carried them a step farther,

in definitely showing the coincidence of the like forms of animals and of vegetation existing on both sides of the straits, dwelling strongly on the presence in both countries of certain noxious animals which were not likely to have been brought over by man.

The investigations of Mr. Martin and Dr. Mantell, extended since by other eminent English geologists, and the theoretical arguments of upheaval and cross-fracture of the Wealden area by Mr. Hopkins, have all strengthened and confirmed the conclusion of the former union of the two countries, which may now be regarded as thoroughly established.

As it is not always easy to determine in the study of Nature the why and the wherefore of all we see, so masked as it may be by transmissional fancies and obscurities, there may yet be a rudiment of truth in most traditions. In more than one case the investigations of geology have given something like a foundation in reality to tales that were before considered only within the bounds of fiction. So that at last we have even come to regard fiction itself as drawing upon reality for its creations; and popular superstitions as founded on some original occurrences, or as illiterate transformations of not untruthful deductions. The recent discoveries of fossil relics of human workmanship lend still greater probability to the idea that many of the old fanciful legends may have been based upon primitive facts or existences in very remote times indeed: and I think we should not quite regard as an idle inquiry some researches into the origin and bearings of the remarkable tales of losses of land and catastrophes which for centuries have been current alike, with very remarkable coincidence, in Cornwall, in Wales, and in Brittany.

Is it not indeed possible that the incidents referred to might have been far more remote in antiquity than the Armorican race from whom these tales have been directly handed down to us, or than the Scandinavian tribes from which the Armoricans have been by some antiquaries thought to have derived them. If primitive man was the associate of the mammoth, why from primitive men should not have come down to us the legend-mystified history of the channel-fissure; and in the legendary losses of land may there not be some original truthfulness of reference, in remote antiquity, to some great catas-

trophe connected with its opening out. Is it impossible that in a first or final upburst "forty miles which erst were land," should "now be sea;" and the similarity of the mammalian deposits in both countries proves that the complete severance had not taken place during at least the earlier part of the Pleistocene era, and it is therefore certain that the final disruption must have occurred only immediately preceding, if not actually within, the limits of the human era, as now ante-dated by recent discoveries.

But let us now return again, after this digression, to the Gault, and as we are at Lympne, we may as well vary our route, and get back to the Folkestone shore through the waving corn-fields and "meadows green." On our left the chalk downs rear their grass-clad slopes, brown and arid—always with the same parched, hungry look, whether the woods and fields below are verdant in the emerald greens of spring, painted with the rosy hues of flowery summer, or golden in the autumn's brighter tints, when

> "O'er the leaves before they fall
> Such hues hath Nature thrown,
> That the woods wear in sunless days
> A sunshine of their own."

Even in winter they change not, and when the snow is on the ground, the bare slopes of the chalk-downs stand out brown and arid just the same as when the hot air vibrates and flickers in the estive sunbeams.

Every now and then, in the plain below, are pits sunk in the superficial brick-earth, and as we pass through Cheriton a tall conical chimney marks the site of a tile-kiln. The clay for the tiles is dug out of the Gault, and round the pug-mill are scattered heaps of little black phosphatic nodules and casts of shells and crabs, the refuse of the washings.

(To be continued.)

NOTICE OF THE FOSSIL REMAINS OF A NEW FRESH-WATER MOLLUSC FROM THE LOWER LONDON TERTIARIES.

By F. E. Edwards, F.G.S.

In making the excavations now in progress for the formation of the great South High Level Sewer in the neighbourhood of Peckham and Dulwich, the works have been carried through a series of deposits, constituting part of the lower London Tertiaries, and distinguished by Mr. Prestwich as the "Woolwich and Reading series." As I learn from Mr. Charles Rickman, the able and zealous curator of the Lambeth Museum of Natural History, who has laboured assiduously in collecting the fossil remains found in them, these deposits at Dulwich, at the depth of twenty-five feet from the surface, comprise a bed of grey sand, and below this, at a depth of about forty feet, and intercalating a bed of clay containing shells and a bed of *Ostreæ*, a band of hard compact sandstone, very slightly calcareous, apparently identical with that at Lee, referred to by Mr. De la Condamine as known there by the name of the "cockle." They contain remains of *Ostrea tenera* (Sow.), *O. pulchra* (Sow.), *O. Bellovacina* (Lamk.), *O. elephantopus* ? (Sow.), a *Bysso-arca* somewhat resembling *Arca (Bysso-arca) Cailliaudi* (Bell.) from the Nummulitic beds of Nice, *Cyrena cuneiformis* (Fér.), *C. deperdita* (Sow.), *C. cordata* (Morris), a new species of *Cyrena*, which has been named by Mr. Rickman *C. Dulwichiensis*, *Modiola Mitchelli* (Morr.) ?, a *Unio* closely resembling, if not identical with, *Unio Solandri* (Sow.), another undescribed species of *Unio*, *Cerithium funatum* (Mant.), *Melanatria melanoides* (Sow.), more generally known as *Melania inquinata* (Dif.), *Calyptræa trochiformis* (Lamk.), a large and undetermined species of *Teredina* (?), *Paludina lenta* (Sol.), another large species of Paludina, much like *Paludina aspera** (Michaud), from the freshwater lime-

* This is probably the species recorded by Mr. De la Condamine as *P. Desnoyersi* (Desh.) ; that species, however, appears to be more globose than the Dulwich shells.

stone of Rilley-la-Montagne, and other estuarine forms; and also masses of leaves of trees, and other vegetable remains. Associated with these are found, sparingly in the clay, but rather more plentifully in the sandstone band, the remains of an undescribed spiral shell, which were at first referred to the genus *Voluta*, because the imperfect casts, in which condition only they were then found, presented a close resemblance to casts of the well known Bognor fossil, *Voluta denudata*. Tolerably perfect specimens have been since obtained, and from these it appears that the columella is without the plaits characteristic of that genus, and that the base of the shell is rounded and entire, and without transverse furrows. The shells, therefore, must be referred, not to the genus *Voluta*, but to some land or fresh-water mollusc, belonging most probably to one of the three families, *Auriculidæ*, *Achatinidæ*, or *Limneidæ*.

The shells are smooth and rather thick, and in their general aspect present much of the character of the *Auriculidæ*, and were there any indication of transverse folds in the columella, they might fairly be considered to be an aberrant form in the group (*Auricula*, Lam., *Geovula*, Swains.), of which *A. auris-Midæ* forms the type. The prominent character by which the shells of the Auriculidæ are distinguished is the presence of one or more thick, well-defined, transverse folds on the columella, and this is, I believe, a constant character: I do not know of any genus belonging to the family in which it is wanting, or evanescent.

The *Achatinidæ*, as a family, are characterized by the truncation of the columella; and they usually have the spire much produced, so as to exceed the aperture in length. One group in this family—inhabiting the West India islands and the adjacent parts of the American continent, (*Polyphemus*, Montf., *Glandina*, Schum.), in which the aperture and spire are nearly equal, and to which the Peckham shells approach more closely than to any other genus in the family—is represented in our Eocene fauna by *Achatina (Glandina) costellata* of the upper fresh-water deposits in the Isle of Wight; but in this group the body whorl is much attenuated at the base, and the columella is strongly truncated.

The distinguishing characters of the *Limneidæ* are the acute spire, the wide aperture rounded in front, and the obliquely twisted

columella. In one genus, however, *Chilina* (Gray), the conditions of the spire and the aperture are much modified; the columella is curved, but is without the oblique twist of the true *Limnœa*, which is replaced by one or more transverse folds. One species in this group, *C. Pehuelcha* (D'Orb.), closely resembles the fossil in question, in the relative proportions of the spire and the aperture, and the general form and aspect of the shell. In another species, *C. Puelcha* (D'Orb.), the transverse fold is almost obsolete in the young state, and is much reduced in importance in the mature shell, while the curve of the columella and the rounded front of the shell correspond with those of the Peckham fossil. The *Chilinœ* are described by D'Orbigny as inhabitants of the clear running streams and rivers of Chili and Patagonia, habitats to which the occurrence of *Glandina costellata* and of *Helix labyrinthica* as Eocene fossils, would prepare us, in some measure, to look for a living analogue of the form in question.

Externally the columella of the fossil shells appears to be straight and simple, but in specimens, in which the inner surface is more displayed, there are indications of a slight and very oblique twist; and I am induced, therefore, on the whole, to consider these shells as constituting an aberrant form among the *Limnœidœ*, partaking of the characters of the true *Limnœa* and of *Chilina*, and to place them between those genera under the generic name *Pitharella*; and I dedicate the species to Mr. Rickman, by whom attention was first drawn to these interesting shells. I subjoin a description of the principal characters which distinguish the genus, and also a description of the species.

Hampstead, 6th May, 1860.

Pitharella (Gen. char.).—Shell sub-cylindrical; spire obtuse, more or less produced; aperture oval-oblong, rounded in front, narrowed behind; columella straight, or very obliquely twisted, arched anteriorly; outer lip simple, acute; inner lip thickened.

P. Rickmani (Spec. descr.).—Shell oval-oblong, smooth; spire subconical, short, varying in height in different specimens; whorls five or six, depressed on the posterior margins, and obtusely angulated on the shoulders. The sutural edge is slightly thickened, forming

a narrow, upright, ribbon-like band, pressed against the preceding whorl, and feebly crenulated by the lines of growth; in well preserved specimens the margin, immediately in front of the sutural band, presents two or three obscure concentric furrows. The last whorl is somewhat attenuated towards the base; the aperture is entire, rounded in front, narrow behind, and very long, nearly equalling four-fifths of the entire length of the shell; the columella is obscurely and very obliquely twisted, and anteriorly is much curved; the outer lip is slightly arched, simple, and sharp on the edge; the inner lip is posteriorly thickened and narrow, anteriorly effuse, flattened, and reflexed, forming an angular ridge on the columella, and confluent with the outer lip.

Size.—The dimensions of my largest specimen, if it were perfect, would be, *Axis*, 2 inches and 2-12ths nearly; *Diameter*, 1 inch.

EXPLANATION OF PLATE V.

PITHARELLA RICKMANI.—Fig. 1.—Front View. Fig. 2.—Back View. Fig. 3.—Portion of *Pytharella*, showing twist in the columella. From specimens in the collection of F. E. Edwards, Esq., to whose liberality we are indebted for this plate.

NOTICE AND DESCRIPTION OF *CYRENA DULWICHIENSIS.*

BY CHARLES RICKMAN, ESQ., Hon. Curator of Lambeth Museum.

In a former communication to the "GEOLOGIST," treating of the fossil fauna and flora observed in Lower Eocene strata passed through at Dulwich and Peckham, in the construction of the Great South High Level Sewer, I mentioned the fact of having discovered in a shelly conglomerate at Dulwich, a new species of the estuarine genus Cyrena, which I proposed to call *Cyrena Dulwichiensis.* In sinking the main shaft, at a depth of fifty to sixty feet, this conglomerate occurred in nodular masses in green shelly sand, intercalated with wedge-like bands of stiff black clay, highly charged

with vegetable remains; but on driving the gallery eastward the conglomerate became regularly bedded, and attained a maximum thickness of four feet, made up plentifully of the shells of *Cyrena cuneiformis*, *C. cordata*, *C. Dulwichiensis*, *Melania inquinata*, and the new genus *Pitharella*, now figured and described by Mr. Edwards. I annex a description of the distinguishing generic characteristics of the *Cyrena Dulwichiensis*, and, as an accompaniment to the figure, some of the prominent peculiarities noticeable in the species.

Cyrena Dulwichiensis (Rickman): Spec. char.—Shell elongately oval, transverse, inequilateral, posteriorly slightly produced, and obscurely truncated; umbones prominent, tumid, curved; lunule large, and of an oblong oval form. The anterior extremity presents on the surface numerous irregular and rather deep concentric furrows, which become shallower as they cross the middle, and almost obsolete over the posterior extremity. The shell is ornamented with irregular longitudinal bands or rays of colour, usually eight to ten on each valve, but varying in number and breadth in different specimens. The shelly matter forming the coloured surface of these bands appears to have been particularly susceptible of disintegration, for most generally it is found to have been decomposed, leaving a perceptible furrow, corresponding with the ray, impressed on the surface. The hinge lamina is much curved, and has three divergent cardinal teeth, of which the central one is slightly bifid, and two unequal, compressed, lamelliform lateral teeth, strongly serrated.

Size.—Length, 2 inches and 1-12th; height, 1 inch and 5-12ths.

EXPLANATION OF PLATE V.

Fig. 4.—CYRENA DULWICHIENSIS. Fig. 5.—Interior of valve, showing the hinge and muscular impressions. From specimens in the collection of F. E. Edwards, Esq.

ON CANADIAN CAVERNS.

By George D. Gibb, M.D., M.A., F.G.S., Member of the Canadian Institute.

(*Continued from page* 179).

21.—Probable Caverns at Chatham.

The greater part of the main road from Carillon to Grenville, a distance of thirteen miles on the northern banks of the Ottawa River, runs over the Calciferous sand rock of the Lower Silurian formation. In many places the surface of the rock is exposed, and beyond the village of Chatham, towards Grenville, and even in Chatham, for a short distance, the road consists of the solid limestone rock. As the surface of the rock is more or less rough or uneven, the road is an uncomfortable one to travel over in a wheeled vehicle. On driving over that part of the rock just near Chatham, a tremendous loud rumbling noise is occasioned by the stage, which is not heard in other situations. This has been attributed to the presence of one or more large caverns situated beneath the road at this place: and, on making inquiry on the spot, I learnt that a prevalent opinion has long been entertained by the country people and many intelligent persons in the neigbourhood, that a considerable cavern does exist in this part of the country in the place mentioned. On the many occasions that I have driven over this road, the loud rumbling noise has been invariably observed by my fellow travellers as well as by myself. Some day an opening into the cavern may be discovered and the mystery solved. The main road is elevated and is probably from seventy to ninety feet above the level of the Ottawa River.

22.—Calquhoun's Cavern, Lanark.

The locality of this cavern is in the northern corner of the township of Lanark, in the county of the same name, Western Canada, on the borders of the small river Mississippi, a branch of the Ottawa. A small branch of the former runs into this township from the neighbouring township of Ramsay, in a south westerly direction from the village of Bellamyville. The cave was discovered in the autumn of 1824, by Mr. Colquhoun, the owner of the ground, who, when clearing his land, came upon a hole at the foot of a tree, which was the first indication of its presence, and his curiosity induced him to descend and examine it. A notice of this discovery appeared in a Canadian newspaper, in November, which was seen by Dr. Bigsby, then in Philadelphia, who wrote to Lieut. Robe, of the Royal Staff

corps at Montreal, upon the subject. That gentleman immediately visited the spot, examined the cave, in which were found a number of bones; and these, by favour of Dr. Wilson of Perth, were all brought to Montreal.

The description of this cave is given by Dr. Bigsby in the Amer. Jour. of Science (vol. ix., June, 1825, p. 354) in two letters to the editor, dated Philadelphia, February and March, 1825. His information was derived from Lieut. Robe. The cavern is ten feet below the surface, with which it communicates by a sort of shaft or passage leading downwards, just large enough to admit the entrance of a man, being two feet three inches wide, by one foot nine inches broad. The cave is twenty-five feet long by fifteen broad, and is five feet high in the middle, gradually lowering at each end. At that part of it the most remote from the entrance, there is a fissure two feet by six inches, and therefore too small to permit of further penetration. The floor was covered with fragments of dark coloured granular limestone, of which the cave itself is formed; whilst the sides and roof were coated with small mamillary concretions of calc-spar. The entire township of Lanark consists of the Laurentian rocks, consisting of gneiss and interstratified bands of crystalline limestone, and I have no doubt whatever that it is in one of these bands that the cave is developed. If it has not been further investigated since its discovery, it might be worth while to enlarge the fissure at its extremity, particularly if it is found on examination to extend much furthur inwards.

A quantity of very large bones, in a state similar to that observed in grave yards, were found chiefly in a heap near, but not under, the aperture from above, many others were scattered among the debris of the floor. Mr. Robe conjectured that the animal to which these remains belonged, must have been too large to have entered the cave alive or whole. As no mention was made whether the bones were encrusted with stalagmite, or formed a breccia, it is presumed such appearances did not exist. In June, 1859, Dr. Bigsby related to me that the bones were transmitted by Lieut. Robe to Dr. Buckland for examination and description; but although they were received, not any published notice of them ever appeared. It is probable, however, that they were those of a deer, which Dr. Bigsby seems to think must have fallen in. If any remains of the antlers were among them when discovered, there could be no doubt of its being the animal supposed.

23.—Quartz Cavern, Leeds.

This cavity is perhaps hardly deserving of a place in this paper, but as it illustrates, to a certain extent, the formation of caverns by explosions in pyritous veins, it is not passed over, although its existence may now be quite forgotten. It is described in "A Sketch of the Topography and Geology of Lake Ontario," by Dr. Bigsby in the "Philosophical Magazine" for 1829. He describes a district thirteen

miles west (south-west ?) of Brockville on the high road to Montreal, which for three miles consist of white translucent quartz in steep and shapeless, often ruinous mounds, but still often betraying in its rents a south-west direction. It is of a fine granular, passing into a crystalline, texture. One of these eminences in the woods, half a mile north of the road, thirty to forty feet high, and near the easternmost of two creeks occurring here, has a vein of iron pyrites under the following circumstances. About the year 1811, a farmer was seeking for his cow in the woods, and when within a short distance from this spot, he was suddenly startled by a tremendous explosion, attended by volumes of smoke and sulphurous odours. On visiting the seat of disturbance he found the following appearances, which Dr. Bigsby thus describes :—" A rounded cavity twelve feet deep and as many long, but not quite so broad, with its sides consisting of very shattered quartz, spotted with brown oxide of iron, and profusely covered with a yellow and white efflorescence of sulphate of alumina, has its lower parts studded with masses of iron pyrites. The vein, which is visible for a yard and a half at the bottom, is described as eighteen inches thick, and disseminates itself into the surrounding quartz rock. This vein may be seen running east with a very high dip, to the distance of a yard and a half.

The Quartz cavern (if it may so be called) is ten miles west of Brockville, and situated in the township of Yonge, in the county of Leeds, and is within a couple of miles of the river St. Lawrence, and will therefore exist in the Laurentian formation, which is here closely approached by the Potsdam sandstone, a white quartz rock.

" Similar phenomena have been noticed in a mountain in Vermont (*vide* Amer. Journ. of Science for Feb., 1821), and in the country towards the head of the Missouri (*vide* Travels of Captains Lewis and Clarke)."

24.—Probable Caverns, at Kingston.

For the present, the existence of caverns at Kingston is wholly conjectural. It has been assumed that because Hamilton's Cove on its north shore is cavernous to a very great degree, that they may be discovered with animal remains in their interior. The limestone portion of Cedar Island is said to be equally cavernous, and Colonel Bonnycastle relates that there are some tokens of vast caverns under Point Henry, as a stream, which is of some volume in the spring of the year, loses itself suddenly there in a chasm.* The limestones of this locality belong to the Trenton formation, and are frequently cavernous.

25 and 26.—Mono and Eramosa Caverns.

The most extensive caverns which have hitherto been discovered in Canada, are found in massive and solid beds of bluish grey lime-

* Tran. Lit. and His. Soc., Quebec, vol. i., p. 65.

stone (containing great numbers of encrinites) belonging to the Niagara group of rocks. The limestones of this formation constitute an elevated plateau at the Falls of Niagara, and running along the south-west border of Lake Ontario for a short distance, they form a terrace which continues in a north westerly direction to Cabot's Head in Lake Huron, and also of the Manitoulin Islands. Mr. Murray has shown that the rocks of this group here form two separate and distinct terraces, the lowest is the most decidedly marked escarpment, exposing strata below the cherty limestone bands which cap the precipices at Flamboro West; whilst the upper, composed of the bituminous limestones and shales, rises more gradually in a succession of steps, terminating at the summit in a vast extent of table land.* The crest of the lower escarpment is formed of the massive beds of encrinal limestone, passing below the cherty band just mentioned, and runs north from Flamboro East, and they gradually increase in thickness as they advance to the northward. Thus, in the seventh concession of Nassagaweya, there is a vertical precipice of this encrinal limestone, from eighty to one hundred feet in height; and in the fourth concession of Eramosa, a branch of the river Speed runs between vertical and solid calcareous cliffs of sixty to eighty feet. In Caledon, the river Credit is flanked by similar cliffs one hundred feet high, which meet and form a crescent shaped precipice, after ascending the valley, over which the river is precipitated in a cascade; in the valley of the Nottawa, in Mono, the same character prevails. Similar cliffs were observed in the townships of Mulmer and Nottawasaga; and in the valley of the Beaver River, in Euphrasia and Artemisia, the same limestone is described as one hundred and twenty feet thick. If a line is drawn on the map almost due north from West Flamboro to Nottawasaga Bay, (the most southern boundary of the Georgian Bay), it will intersect the first six townships named, although they lay in four counties. The two last named townships lay a little further westward, and form the extreme western boundary of the county of Simcoe. A good view of the upper half of this interesting part of the country is given in a sketch of the valley of the Nottawasaga, by Mr. Sandford Fleming in the first volume of the first series of the "Canadian Journal," p. 223.

It is at the base of this limestone, the course of which has just been described, that a great series of huge caverns have been discovered, the roofs of which are studded with stalactites. The most extensive of those that were visited by Mr. Murray were what I shall for the present call the Mono and Eramosa caverns.

The *Mono Cavern* is situated on the twelfth lot of the second concession, east of the Hurontario Road, in the township of Mono, which forms the south-west angle of the county of Simcoe, on a branch of the Nottawasaga river.

The *Eramosa Cavern* occurs in the fourth lot of the fourth concession, in the township of Eramosa, county of Waterloo, on a branch

* Geol. Survey of Canada. Report for 1850-51.

of the river Speed, near Mr. Strange's mill. It extends under the cliff for between thirty and forty yards, and is about the same in width at its mouth; the roof, from five to six feet in height at the entrance, slopes towards the floor inwards, and at the termination of the distance specified, the space becomes insufficient to permit of a man's body to pass, so that the extent of the cavern beyond is unknown; the roof and floor are studded with small stalactitical incrustations.

The account given of these two caverns is meagre enough, but several others are known to exist, although they are not described; their dimensions, however, are large, and it is probable that a distinct and important series of caverns pervade almost the whole of that part of the peninsula of western Canada, which is traversed by the Niagara limestones. It is highly important that the attention of scientific men in Canada should be directed to the subject of their discovery and investigation, at the same time making careful search for the bones of animals.

27.—Cavern in the Bay Islands, Lake Erie.

The Bass Islands, two in number, lie some miles to the south-west of Point Pele island, at the western end of Lake Erie, and are formed of the superior group of the Helderberg series of rocks, which constitute the base of the Devonian system. In one of these islands is a cavern, which is entered by a round hole, a yard in diameter, gradually widening for fifty feet, when it opens into a circular space, one hundred feet in diameter, and seven feet high. The roof is studded with brown stalactites, frequently hollow, and seldom more than three-fourths of an inch thick, or longer than three inches. The floor is covered with stalagmite. This description was furnished to Dr. Bigsby when near this place in 1819, by Lieut. Dix, aide-de-camp to the American General Brown.* Dr. Bigsby was shown several conical stalactites from this cavern at Moy, opposite to Detroit; they were ten inches long, by seven inches broad at their base. It seems to me not improbable that this cave was much higher at one time, and that the greater part of the roof consists of a great thickness of the stalactitical carbonate of lime.

28.—Subterranean Passages in the Great Manitoulin Island, Lake Huron.

This very large and beautiful island forming the northern boundary of Lake Huron, with a length of eighty, and average breadth of twenty miles, is well covered with streams and lakes. A series of bold escarpments run longitudinally through the whole length of the island, and are described by Mr. Murray† as varying from one hun-

* Jour. of Science and Arts, vol. iv.: 1828.

† Geological Survey of Canada, Report of Progress for 1847-8.

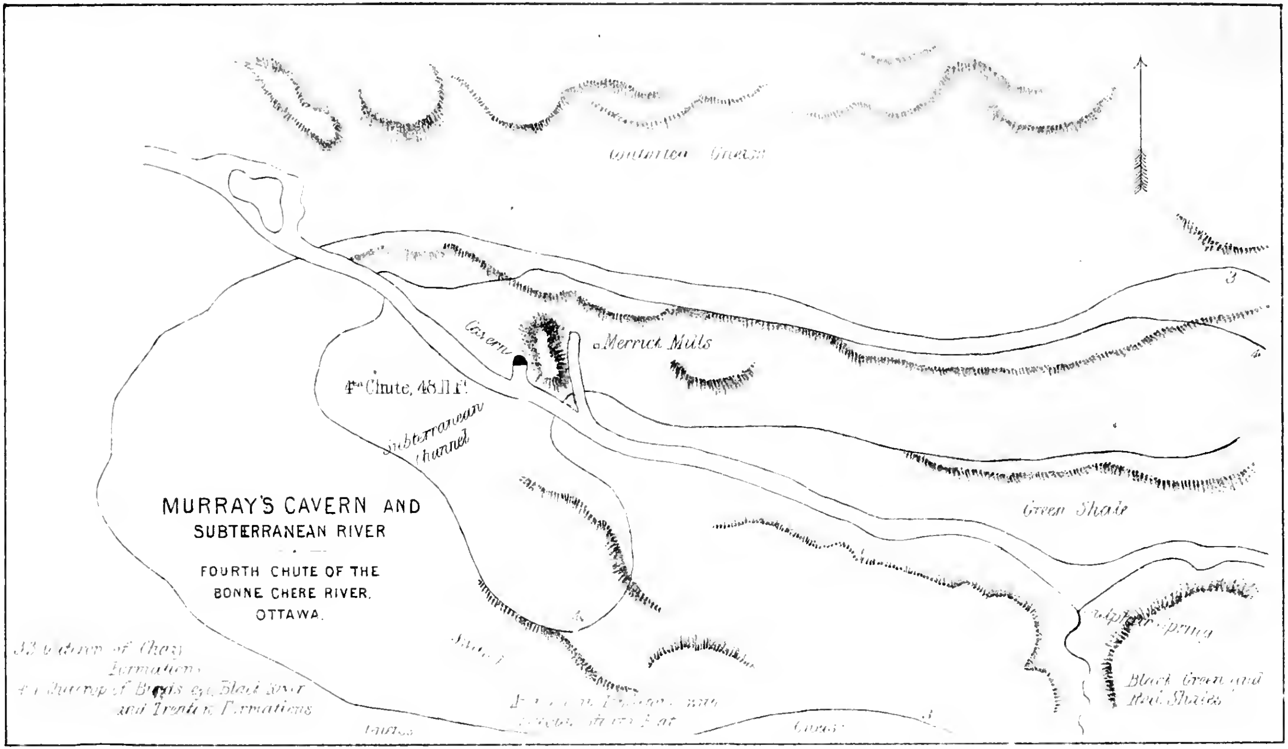
dred and fifty-five to three hundred and fifty-two feet in height above the level of the lake. At that part of the island near Manitonwaning there is a lake of an hour-glass shape, possessing an area of fifty-five square miles (the area of the whole island is sixteen hundred square miles), associated with which there is a peculiarity, especially described by Mr. Murray. He found that this lake was one hundred and fifty-five feet above Lake Huron, and the "question of interest connected with this lake, which constitutes its peculiarity, is the source whence it derives its supply of water." Mr. Murray found but one small stream to be its visible supply; and although thus receiving so scanty a tribute from the surrounding country, it furnished water for three large brooks, which fall from it to the south, the west, and the north. These supply several lakes, ponds, and streams, among others, Tecumseth Lake, the level of the water in which was found in the early part of August to have been much higher than it must have been in the spring or some later period. This great island consists chiefly of the Niagara limestones; and as this is known frequently to give subterranean passage to streams, Mr. Murray thinks it probable that such a communication may exist between these lakes, and that there may be others in connection with them, and thus the water of Tecumseth Lake may arise from the drainage of a considerable part of the island.

It is possible that further investigation may develope some interesting facts in relation to these subterranean communications, and lead to the discovery of actual caverns. It is earnestly hoped that the labour of investigation may be undertaken by persons residing on the island.

29.—Murray's Cavern and Subterranean River, Ottawa, (See Map, pl. x.

This very singular cavern exists at the fourth chute of the Bonne Chère river, one of the tributaries of the Ottaway river, recently explored by Mr. Murray, of the Canada Geological Survey. At the chute a portion of the water turns abruptly off at right angles to the general course, running northerly for about ten chains through a great cavern formed in the Trenton limestone of the Lower Silurian formation. Mr. Murray describes the cavern as naturally nearly dry, except during freshets. Mr. C. Merrick, an enterprising proprietor of the cave and its vicinity, has caused a dam to be thrown across the main body of the stream, near the middle of the chute, which turns a sufficient quantity of water through to convert the channel into a mill-race, and the fall from the lower end is thus advantageously applied to drive the water-wheel of his mill.* The strata of limestone and shale exposed near Mr. Merrick's mill are in all forty-six feet thick, and well charged with fossils, of which Mr. Billings gives a list of sixteen Trenton, four Black river, one Birdseye,

* Geological Survey of Canada, Report for 1853, p. 77.


Green Shale
Merrick Mills
Cavern
4th Chute, 48 ft
Subterranean channel
Black Green and Red Shales
3
4
MURRAY'S CAVERN AND
SUBTERRANEAN RIVER
FOURTH CHUTE OF THE
BONNE CHERE RIVER.
OTTAWA.

and two of the Chazy limestone species.* The fossils are very numerous at the mouth of the cavern and large flat exposure of strata above the bridge close by.

It is a source of considerable regret to me that a more extended account of this very interesting cavern has not been given, with a description of its interior, and where and how the stream disappears. From other sources I learn the cavern is not only extensive, but likely to branch off in several directions.

30.—Probable Caverns in Iron Islands, Lake Nipissing.

Iron Island lays about midway between Duke's Point, one of the Indian settlements at the western extremity of the Great North Bay, and the French River, in Lake Nipissing, recently explored by Mr. Murray. It is composed principally of the Laurentian rocks; here and there, however, the crystalline limestones of this formation crop out, being frequently associated with iron ore. The beach near the outcrop is strewed with masses of all sizes, from great boulders weighing several hundred pounds to small rounded pebbles not larger than marbles. The limestone thus associated with the iron-ore is frequently cavernous, and the numerous crevices and smaller fissures are thickly lined with crystals of blue fluor-spar and red sulphate of barytes, or cockscomb-spar. As the cavernous crystalline limestones are here interstratified with, and cut across by, trap, often assuming the concretionary character, it is probable some day that caverns may be discovered in the elevated cliffs of the island.†

(To be continued.)

THE CARBONIFEROUS SYSTEM IN SCOTLAND CHARACTERIZED BY ITS BRACHIOPODA.

By Thomas Davidson, Esq., F.R.S., F.G.S., Hon. Member of the Geological Society of Glasgow, etc., etc.

(Continued from page 184.)

XLII.—Chonetes Hardrensis. Phillips. Pl. ii., figs. 2-7.

Orthis Hardrensis. Phillips' Figures and Descriptions of the Palæozoic Fossils of Cornwall and West Somerset, p. 138, pl. lx., fig. 104, 1841.

The shells composing this species vary but slightly in shape, being marginally semicircular, concavo-convex, and about one-third wider than long. The hinge-line is straight, and either a little shorter, with its cardinal angles rounded, or

* Geol. Survey of Canada. Report for 1855.

† Geol. Survey of Canada. Report for 1857, p. 154.

somewhat longer than the greatest width of the shell, with rectangular or slightly acute and extended terminations. Both valves are provided with narrow sub-parallel areas, the ventral one, which is the largest, being divided by a small fissure, partially covered with a pseudo-deltidium; while in the middle of the ventral one there exists a prominent V-shaped cardinal process. The ventral valve is moderately convex, and flattened towards its auriculate cardinal extremities. The beak, which is small and incurved, does not overlie the hinge-line; while the dorsal valve assumes in different specimens a greater or lesser degree of concavity, and follows the curves of the opposite one. Exteriorly the surface of the ventral valve is covered with numerous small thread-like radiating striæ, which increase in number by occasional bifurcation, or interstriations at various distances from the beak, so that as many as one hundred and twenty ribs may be counted round the margin of certain specimens, while at irregular distances small spines projected from the rounded surface of the striæ. In addition to these, on each side of the beak there exists along the cardinal edge from five to nine slanting tubular spines, which become longer and larger as they approach the extremities of the cardinal edge. The surface of the dorsal valve is striated as in the ventral one; and minute perforations or punctures may be perceived over the entire surface of the shell, and which are the exterior orifices of the canals which traverse the shell, as in Productus.

In the interior of the ventral valve there exists a tooth on each side of the small fissure, and which fitted corresponding sockets in the opposite valve, while the occlusor and divaricator muscular impressions are very similar to those of *Productus giganteus*, but proportionately much smaller, as may be seen by a glance at the figures of the two species. Under the cardinal process, in the interior of the dorsal valve, a mesial ridge or plate extends to nearly two-thirds of the length of the valve, and on either side may be observed two well defined occlusor muscular scars, the four being comparatively larger or more spread out than is generally the case with Productus; while outside, and in front of these, are situated the reniform impressions.

Chonetes Hardrensis is a small species, rarely attaining in Scotland eight lines in length by twelve in width. It varies, likewise, in the number of its striæ, and these are very much finer or coarser in some specimens than in others.

A small variety, which I take to be the same species (pl. ii., fig. 7), occurs by millions in certain localities, such as at South Hill, Campsie, in a bed of shale on the horizon of the Hosie limestone of the Carluke section; and are associated with *Sp. Urii* in almost equal abundance. The striation in this small Chonetes is generally so fine that it can hardly be distinguished without the help of a lens; and although it has been thought that this little form might constitute a distinct species, I am still inclined to view it simply as a small variety of *C. Hardrensis*.

The determination and study of the present species has given me much trouble; and although I have spent much time in the endeavour to arrive at a satisfactory conclusion, it is not without some hesitation that the term *Hardrensis* is here provisionally retained; provisionally, because I am at present unable to determine whether Phillips' Devonian shell is the same as that to which Schlotheim in 1820 applied the denomination *Sarcinulata*, as Prof. de Koninck's illustrations of this last differ so much from those given by Prof. Schnur and some other palæontologists. I am likewise uncertain whether J. de C. Sowerby's *Lept. sordida* (1840) be really a synonym of the last-named shell, or different from Phillips' *Hardrensis*, as has been stated to be the case by some authors; and lastly, because my learned friend, Prof. de Koninck, who has paid so much attention to the species of the genus, maintains a different opinion to that here recorded, but not absolutely denying the possibility of mine being correct.

Until within a twelvemonth since, or less, Scottish and other geologists had been in the habit of distinguishing the Chonetes we are now describing by the name *Hardrensis*; subsequently, from finding at p. 206 of the "Monographie du Genre Chonetes" that Prof. de Koninck had referred the shell, pl. xvi., figs. 10-11 of Ure's "History of Rutherglen, etc.," to D'Orbigny's *C. variolata*, the last-mentioned name was by many adopted for the species, and likewise so labelled upon the tablets in the Museum of Practical Geology. With the desire to arrive, if possible, at a correct identification, I forwarded several specimens of the Scottish shell to Prof. de Koninck, in order to ascertain whether he was satisfied that the shell in question really belonged to D'Orbigny's species, as had been so stated to be in his "Monographie;" and in answer I was informed that he had subsequently determined that our shell could not be referred to *C. variolata*, which last possessed finer and more numerous striæ; that the Scottish shell occurred also at Visé, in Belgium; and that he had intended to describe it in the supplement to his "Monographie" by the name of *C. alternata.* I must also mention that having obtained from Sir Richard Griffith the loan of Prof. M'Coy's various so-termed species of Chonetes, it did appear to me that several among them, such as *C. sulcata*, *C. volva*, *C. gibberula*, and one or two others should be united into a single species, and that they were likewise specifically undistinguishable from our Scottish shell (?); but here again my distinguished Belgian friend disagreed with me; for although he was prepared to admit that *C. volva*, *C. sulcata*, *C. crassistria*, and *C. gibberula* should be united into a single species, he still considered his *C. alternata*—our Scottish shell—as specifically distinct. I also received from Prof. Phillips the loan of his four best and figured examples of *C. Hardrensis*; and having compared these with several of our Scottish specimens, the result was that I could perceive no differences in the shape, areas, and striation, so that I deemed it preferable to allow our Scottish *Chonetes* to retain the name *Hardrensis* until the subject might be further discussed. But I am, however, unable to perceive what led Professor Phillips to suppose that his species was provided with "large cordiform muscular impressions;" and in conclusion I must also observe that although the ribs of *C. variolata* appear to be finer and more numerous than is the case with the generality of specimens of *C. Hardrensis*, there does not appear to exist much difference in the shape of the Scottish and American species.

C. Hardrensis is found at Gare, in Lanarkshire, at two hundred and thirty-nine fathoms below "Ell coal;" three hundred and forty-three at Raes Gill; three hundred and fifty-six at Hillhead. It occurs also at Capel Rig, East Kilbride; Auchentibber and Calderside, High Blantyre; Brockley and Middleholm, near Lesmahago; and Robroyston, north of Glasgow. In Renfrewshire, at Arden- and Orchard-quarries, Thornliebank. In Stirlingshire, in various stages, such as Craigenglen, Mill Burn, the Campsie main limestone, Corrie Burn, etc. In Ayrshire, at West Broadstone, Beith; Auchenskeigh, Dalry; Goldcraig, Kilwinning; Hallerhirst, Stevenston, and Craigie, near Kilmarnock. In Haddingtonshire, at East Barns, near Dunbar. It has also been found in Fifeshire and in the island of Arran.

XLIII.—Chonetes Buchiana. De Koninck. Pl. ii., fig. 1.

Chonetes Buchiana. De Koninck's "Description des Animaux Fossiles du Terrain Carbonifere de la Belgique," p. 208, pl. xiii., fig. 1, 1843; and "Monographie du Genre Chonetes," p. 218, pl. xx., fig. 17.

The valves in this species are concavo-convex, and marginally semi-circular, with a straight hinge-line as long as the greatest width of the shell. The ventral valve is moderately convex, and somewhat flattened near the hinge-line,

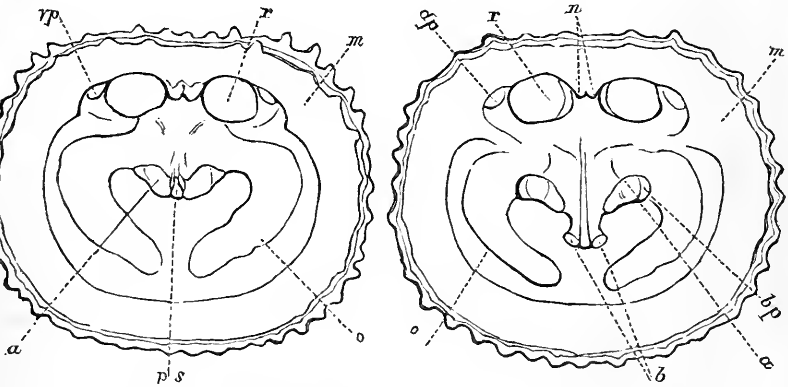
where it forms small auriculate expansions. The area in both valves is narrow, and divided in the ventral one by a small fissure covered with a pseudo-deltidium. The dorsal valve is concave, and follows the curves of the opposite one. Externally each valve is ornamented with about fourteen simple ribs, with interspaces of almost equal breadth. No cardinal tubes could be observed or were preserved in the specimens under description, which measured five lines in length by six and a-half in width. The interior is unknown.

Of this elegant species I am acquainted with but a single example, which was found at Gare, in Lanarkshire, at two hundred and thirty-nine fathoms below "Ell coal." Its identification with *C. Buchiana* is given upon the authority of Prof. de Koninck. It appears to be likewise rare in Belgium.

FAMILY CRANIADÆ.

Genus CRANIA. Retzius. 1781.

The shells composing this remarkable and widely-spread genus vary much in shape, although not much difference has taken place in this respect in time, for some Palæozoic species can hardly be distinguished from more recent and even living types. They are all marginally more or less circular or sub-quadrate,



Ventral, or Attached Valve. Dorsal, or Free Valve.

Lign. 9.—*Crania Ignabergensis* (var.). Cretaceous.

a, Occlusor (Hancock) = anterior adductors (Woodward).
r, Divaricator (H.) = posterior adductor (W.).
v p, Ventral adjustor (H.)
d p, dorsal adjustor (H.) = protractor sliding muscle (W.).
p s, (?) Anterior extremity of dorsal adjustor (H.).
b p, Brachial muscle, posterior extremity (H.) = retractor sliding muscles (W.).
b, Brachial muscle, anterior extremity (H.) = retractor sliding muscles (W.).
n, Mesenteric muscle, destined probably to draw the alimentary tube backwards (? H.)
o, Ovarian (?) ; *m*, granulated margin.

rarely free, but generally attached to marine bodies by the umbo (when such does exist), or by the entire surface of the lower or ventral valve; and it is from this circumstance that the ventral or attached valve varies so much in shape and sculpture. The upper or dorsal valve is always more or less limpet-shaped, with a sub-central vertex, the surface being smooth or variously sculptured by concentric or radiating striæ, or ribs, some also possessing a spiny investment. There exists no articulated hinge, the valves being kept in place by a peculiar disposition of its muscles; and although the animal

has not been hitherto completely investigated, we will give figures of the interior of the valves, for the sake of explaining the more recent but provisional interpretation and names that have been applied to the muscular impressions by Mr. Hancock. But we must hasten at the same time to observe that the interior appearance and shape of the muscular and other impressions are very different in detail in certain species, although very similar in others. The figures here given will however suffice to explain the general character.

Mr. Hancock, who at my request in May 1859 examined the animal of three or four badly preserved specimens of *C. anomala* (the only specimens then to be procured), has informed me that the impressions *a* are undoubtedly due to the occlusor, *r* to the divaricators, and that when the former muscles relax and the latter contract, the fluid in the perivisceral chamber will be forced forwards, and thus the valves will be opened a little in front, the action being the same as in Lingula; that *v p* is due to what may be termed the ventral adjustors, that these muscles form a scar close to the outer border of the divaricator in the ventral valve. The other extremities of this muscle converge and pass round the outer margin of the occlusor, to which they adhere; but Mr. Hancock could not exactly determine how they terminate. *d p* are considered due to be the dorsal adjustors (?), one end of the muscle being attached to the dorsal valve, close to the outer border of the divaricators, the other most probably to the anterior process of the ventral valve; although this could not be satisfactorily determined, from the indifferent state of preservation of the specimens, at any rate the fibres of this extremity were firmly united to the inner border of the occlusors. The brachial muscle has both its extremities attached to the same valve (the dorsal)—the anterior end to the ventral process, the dorsal close to the outer margin of the occlusor, with which it blends its fibres; that the arms are fixed to these muscles, which perhaps may be named the brachial. The mesenteric (*n*) is a flat thin membranaceous muscle, binding the dorsal mysentery to the process of the hinge-margin, to which, according to Mr. Woodward, the cardinal muscle is attached; but we may hope that before long Mr. Hancock will have been able to investigate anatomically some well-preserved examples, which may be dredged alive close to some portions of the Irish and Scottish shores. The oral arms are thick, fleshy, and spirally coiled; the volutions are few, and directed vertically towards the cavity of the dorsal valve, somewhat as is seen in Discina and other genera. We may also notice that the brachial muscle is very closely united to the occlusor; that it is difficult to distinguish the two in the generality of specimens.

Dr. Carpenter has stated the structure of the shell in this genus to be widely different from that of Brachiopoda generally, but as still conformable to it in being penetrated by canals which are prolonged from the lining membrane of the shell, and which pass towards its external surface, these differing, however, from Terebratulæ in not arriving at that surface, and in breaking up into minute subdivisions as they approach it.

XLIV.—Crania quadrata. M'Coy. Pl. v., figs. 12-21.

Orbicula quadrata. M'Coy, "Synopsis of the Carboniferous Fossils of Ireland," p. 104, pl. xx., fig. 1. 1844.

This species varies much in shape, on account of its mode of attachment, which is by the entire surface of its lower valve; but when quite regular, is marginally sub-quadrate, almost circular, or slightly elongated, oval: the posterior edge being usually straight, or with a slight inward curve, while the shell is at the same time wider anteriorly than posteriorly. The upper or free valve is conical, or limpet-like, the vertex being sub-central and closer to the posterior than to the anterior margin. Externally the surface is marked with

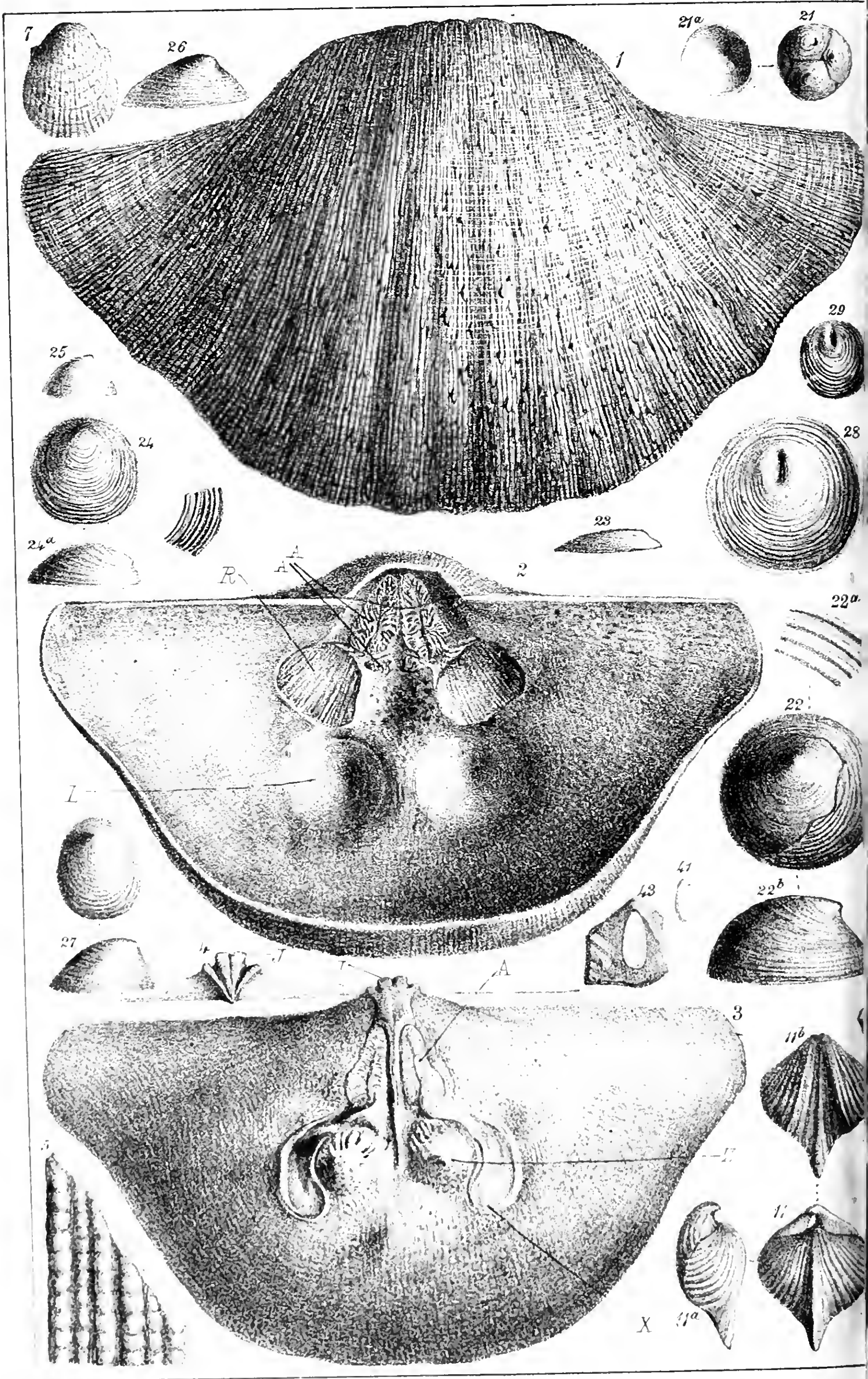
numerous but irregular concentric striæ, or lines of growth, which give to the shell a somewhat roughened appearance. The interior of the attached valve is surrounded by a raised thickened border of moderate width, and upon it the tubular shell-structure is sometimes clearly discernible. In each corner of the disk, close to the posterior inner margin of the raised border, may be seen two somewhat circular, slightly convex, and prominent—but widely separated—muscular scars; while towards the centre of the disk two other prominent but approximate muscular impressions exist, and which are at the same time somewhat hollowed out along their middle. Mr. Hancock attributes the two first-mentioned scars to the divaricator, while the central pair ar ereferred to the occlusor: the other muscular, ovarian, and vascular impressions which should exist in the interior were not sufficiently defined in the present species to admit of their being accurately described. The interior of the upper or free valve has not been hitherto discovered; and none of the Scottish specimens that have come under my inspection exceeded seven lines in length by about the same in width.

The mode of existence peculiar to this as well as to other similarly constructed species is the cause of the great irregularity in shape assumed by the larger number of individuals; for it was the habit of the young of this, as well as of other species of the genus, to fix themselve as parasites to all kinds of submarine objects, and they were sometimes so numerously and closely clustered together, that their individual regular growth was prevented, from which it can be easily understood that in such cases the animal must have been compelled to develope itself in whatever direction it could find available space. When first formed and up to a certain age the shell of the attached valve was exceedingly thin, and adhered so closely to the surface of the object to which it was fixed, as to have reproduced all the inequalities of its surface, but with age, and from the shell acquiring greater thickness, these inequalities were generally levelled. Nor is it an uncommon circumstance to find the roughness or sculpture of the object to which the lower valve adhered likewise reproduced upon the outer surface of the upper or unattached valve, in a very similar manner to what we find to be the case with certain species of oyster.

Although the Crania we are at present describing is far from being uncommon in certain Scottish localities, it does not appear to have been noticed here until the early part of 1858, in which year I received from a friend in Carluke several examples of the attached valve clustered round fragments of various species of encrinal stems, and at a subsequent period bivalve and separate valves were obtained in great abundance in other localities in Scotland, attached to the shell of several species of Brachiopoda and other marine bodies.

It is no easy matter to distinguish certain forms of Crania: several species bear so close a resemblance to one another that I have felt somewhat embarrassed how to determine that to which the Scottish shell should be referred. Having submitted several examples to Prof. de Koninck, he assured me that it could not be identified with his *Crania (Patella) Ryckholtiana*, but that it might be the same as his *Crania (Orbicula) truncata* (?) It was not until I had been able to study the original types and other examples of Prof. M'Coy's *Crania (Orbicula) quadrata* (kindly communicated by Sir R. Griffith) that I could identify the Scottish shell with the Irish author's species.

At Gare, in Lanarkshire, it has been found at two hundred and thirty-nine fathoms below "Ell coal;" three hundred and forty-three at Langshaw Burn; and three hundred and seventy-five at Kilcadzow. It occurs also at Auchentibber and Calderside, High Blantyre; Capel Rig, East Kilbride; Brockley, near Lesmahago; and Robroyston, north of Glasgow. In Ayrshire, at West Broadstone, Beith; Goldcraig, near Kilwinning; Cessnock, near Galston; and on the bank of the stream Pomillen, near Strathavon. In Renfrewshire, at



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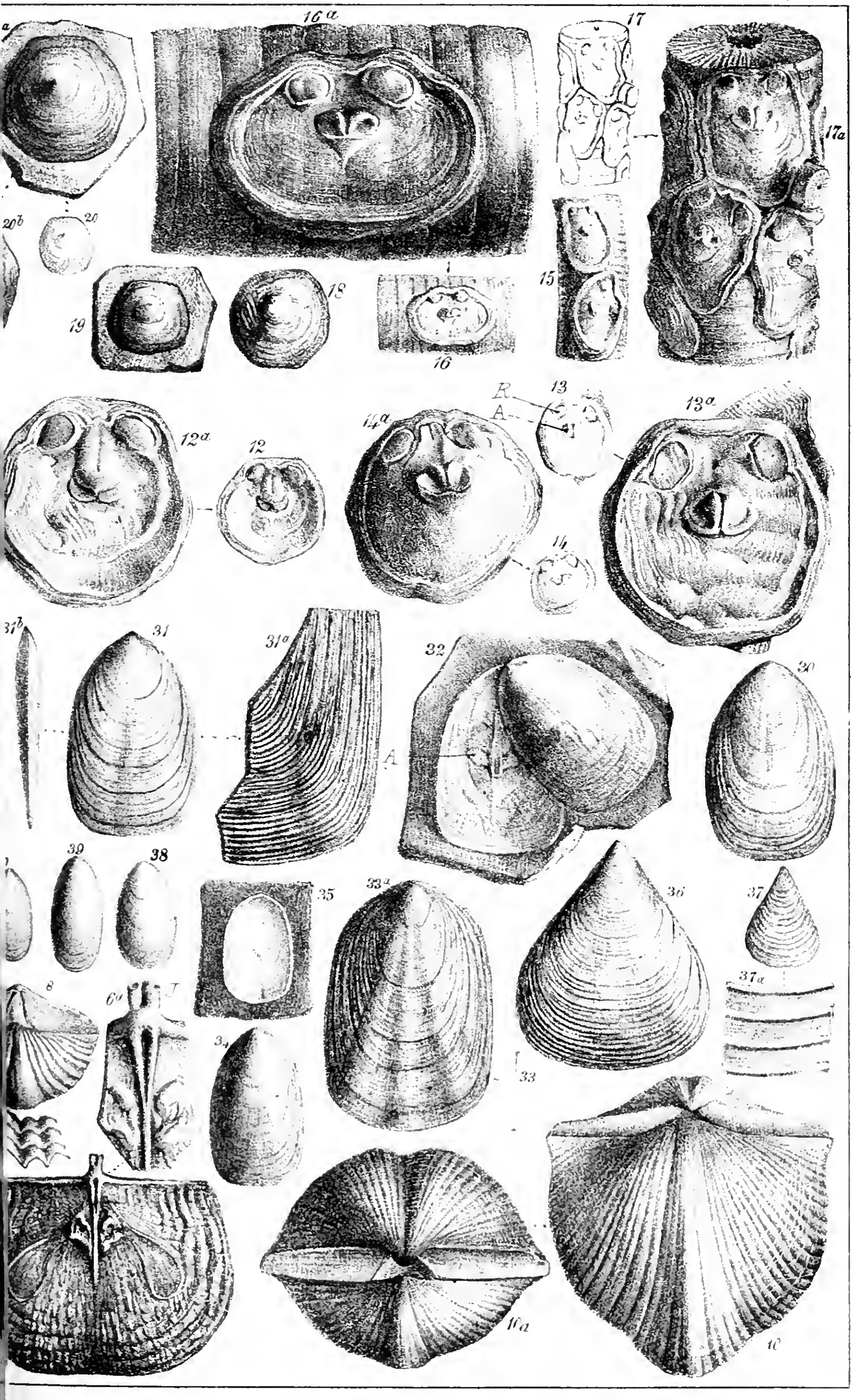
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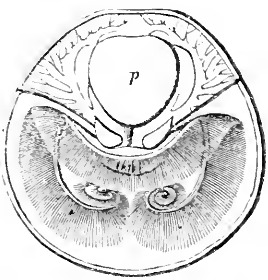
Howood, near Paisley; and Orchard-quarry, Thornliebank. In Kircudbrightshire, in strata cropping out on the sea-shore near Kircudbright. In Stirlingshire, in the Balglass Burn beds, and in those of the Campsie main limestone, &c., and Corrie Burn.*

Family Discinidæ.

Genus Discina. Lamarck. 1819.

The shells belonging to this genus are usually circular, or longitudinally oval; the larger or imperforated valve being conical, or limpet-like, with the apex inclining towards the posterior margin. The lower valve is conical, opercular, flat, or partly convex, and perforated by a narrow, oval, longitudinal slit, which reaches to near the posterior margin, and which in recent species is placed in the middle of a depressed disc; the shell being always attached to marine bodies by means of a pedicle, and never by the substance of its shell as in Crania. The valves are unarticulated, and kept in place by a particular disposition of muscles; the occlusor and divaricator impressions being somewhat similarly situated to those of Crania.

Much has still to be done before the animal will have been completely and satisfactorily anatomically investigated. The oral arms have been described by Mr. S. P. Woodward, in his excellent Manual, as being curved backwards, returning upon themselves, and ending in small spires, directed downwards towards the ventral valve, as in the subjoined figure; and the only process



In this diagrammatic representation of the animal of Discina, by Mr. Woodward, the extremities of the labial arms are displaced forwards, in order to show their spiral terminations.

which could possibly have afforded support to the arms is developed from the centre of the ventral valve, as in Crania. In recent species the shell is stated by Dr. Carpenter to be horny and minutely punctate, the tubuli being generally arranged in fasiculi, so that their transverse section presents a series of dots. Dr. Gratiolet believes, however, that the shell is not entirely composed of a horny substance, but somewhat similar to that of Lingula, although the calcareous element is enormously greater in the last-named genus. The chemical composition of the shell of Discina has been stated by Monsieur S. Cloëz to be similar to that of Lingula, of which an analysis will be found further on.

* In Ireland *C. quadrata* is found at Rahan's Bay, in Donegal. Appears to be a rare shell in English Carboniferous strata, a single example having been hitherto found by Mr. C. Moore, at Holwell, near Frome. It occurs also at Tournay, in Belgium, and at Tuscombia, Alabama, in America. It may likewise be observed that many species of *Crania* have been confounded with *Discina*, from the fact that it is often very difficult to distinguish certain fossil species when the interior cannot be examined.

Discina appears to have existed during almost the entire series of Palæozoic and Mesozoic periods up to the present day; and it is probable that the animal was not at any period the inhabitant of very deep water, for all the recent species of Lingula and Discina, or those species with a horny shell, have prevailed in the littoral zone, and do not appear to have descended deeper than about eighteen fathoms. The reader is referred for more ample details to Prof. Suess' admirable "Memoir on the Habitat and Distribution of the Recent and Fossil Brachiopoda," recently published in Vienna.

XLV.—Discina nitida. Phillips. Pl. v., figs. 22-29.

Orbicula nitida. Phillips' "Geol. of York," vol. ii., p. 221, pl. xi., figs. 10-13, 1836, = *O. cincta,* Portlock's "Report of the Geol. of Londonderry, &c., pl. xxxii., figs. 15, 16, 1843, = *D. bulla,* M'Coy's "British Palæozoic Fossils," pl. iii*d*., fig. 32.

The shells composing this species are marginally circular, or elongated oval, the posterior portion being rather narrower than the anterior one. The larger or free valve is conoidal, or limpet-like, and more or less elevated, the pointed apex being situated at variable distances between the centre and the posterior margin, but it is not always the most elevated portion of the valve. The surface of the shell is covered with numerous small irregular concentric wrinkles, or striæ. The smaller or lower valve is somewhat flattened, or slightly concave towards its anterior margin, with an oval-shaped foramen, surrounded by an elevated convex margin, which extends from near the centre of the valve to a variable distance from the posterior edge. This valve is likewise ornamented with numerous small irregular concentric ridges, or wrinkles, with small flattened interspaces. No interiors have been hitherto obtained; while the largest Scottish examples I have seen measured ten lines and a-half in length by about the same in width, the depth or elevation of the larger valve being about six lines.

After a lengthened examination of *Discina cincta,* as well as of *Discina bulla,* I could perceive no valid grounds for separating these two so-termed species from *D. nitida*; and any one possessing a sufficiently numerous series of specimens of the last named form would, I think, soon perceive that Phillips' shell presented every degree of elevation—from that of an almost depressed shell to that extreme "inflated bubble-like form," described by Prof. M'Coy. I am therefore quite disposed to concur in the Irish author's opinion when he considers *D. cincta* as nothing more than the perfect condition of *D. nitida*; for when the outer surface of the last named shell is absent, which is often the case, the cast is generally almost smooth, or marked only with a few faint concentric and radiating lines, a circumstance which has apparently led some palæontologists to believe that Phillips' shell was smooth, while that of Portlock's was concentrically striated.

Discina nitida is a common species in certain Scottish localities. It occurs at Belston Place Burn, in Lanarkshire, at one hundred and seventy-three fathoms below "Ell coal;" two hundred and thirty-nine at Gare; two hundred and sixty-five at Belston Burn; and three hundred and fifty-four at Raes Gill; all in the parish of Carluke.* It is likewise found at Haw-hill, near Lesmahago; Auchentibber and Calderside, High Blantyre; and Capel Rig, East Kilbride. In Renfrewshire, at Arden-quarry, Thornliebank. In Stirlingshire, at Craigenglen; and in the Balgrochen Glen ironstone, etc. In Ayrshire, at Craigie, near Kilmarnock; Cessnock, parish of Galston; and Netherfield, near Strathavon. In Fifeshire, at Strathkenny, St. Andrews, &c. In Haddingtonshire, at

* Identical specimens are found in Pike and Adams county, Illinois, America.

Cat Craig, near Dunbar. It occurs also in Edinburgshire, and along the Berwickshire coast, from the mouth of the Tweed to Ross.

Family Lingulidæ.

Genus Lingula. Bruguière. 1789.

The limit of variation among the shells composing the genus Lingula appears to be more restricted than what is prevalent among the generality of other genera and species of Brachiopoda. It is, therefore, very often no easy matter to distinguish and correctly determine some fossil species, even when occurring in different and often widely separate geological periods.

The shell of Lingula is thin, equilateral, usually longer than wide, and broader at the front than at the beaks, which are likewise more or less pointed, while the front is either nearly straight, or with a slight inward or outward curve. The shell is also sub-equivalve: the extremity of the beak of the dorsal valve is somewhat more elongated and pointed than that of the ventral one.* The external surface is also either nearly smooth, or concentrically striated. The valves are usually moderately convex, and generally deepest or most elevated towards the beak, and become more flattened as they approach the front. The apex of the dorsal valve is likewise situated quite close to, but not contiguous with, the rounded margin of the beak, and by which character the valves can be readily distinguished, both in the recent and fossil condition.

When alive, the valves of Lingula were slightly gaping at each end, contiguous only along the lateral margins; but the animal could at its will, by the action of certain muscles, close or draw together one or other extremity; nor does there exist any articulation, the valves being kept in place by the means of a complicated system of muscles, to be hereafter described. The animal was also provided with a very long pedicle of a peculiar construction, which was chiefly attached to the inner groove, situated in the beak of the ventral valve; and when alive did not inhabit great depths, most recent species having been found at low-water buried in sand.

The intimate shell-structure of Lingula has been described by Dr. Carpenter; and we will therefore only refer to Dr. Gratiolet's and Mr. S. Cloëz' more recent observations. The first named *savant* states that the shell is composed of two distinct elements, the one being horny, the other shelly; that they are disposed in layers, or thin laminæ, which succeed each other alternately from the convex surface of the valves, the outer or superficial one being horny; that these layers have not the same thickness, the testaceous ones being thickest on and near the visceral side, while the horny ones are more so towards the exterior surface; and that while the horny layers are entirely formed of parallel fibres, without trace of perforations, the testaceous ones are traversed by a multitude of minute canals, recalling those of the Terebratulidæ.† Mr. S. Cloëz has like-

* Anatomists appear to differ as to the names by which the valves should be designated; it may therefore be as well to mention those that are synonyms. The shortest is the dorsal valve of Woodward, Hancock, etc.; = valve inférieure, Gratiolet; = valve droite, Vogt. The longest is the ventral valve of Woodward, Hancock, etc.; = valve superieur, Gratiolet; = valve gauche, Vogt. Mr. Hancock is of opinion that if the names of the valves were to be changed, that they should be called anterior and posterior. In the present paper we will continue to make use of those first mentioned.

† I have considered it desirable to reproduce these details, as they are new to British palæontologists, and have been taken from the first portion of Dr. Gratiolet's recently published memoir on the anatomy of *Lingula anatina*; and I avail myself of the present opportunity to express my grateful thanks to the distinguished French anatomist for the high honour he has conferred by dedicating to me the results of his admirable researches. For details concerning the animal of *Lingula*, I must refer the reader to the following memoirs:—Cuvier, "Mémoire sur l'Animal de la Lingula:" 1797 and 1802. Vogt, "Anatomie der Lingula anatina:" 1845. Owen, "On the Anatomy of the Brachiopoda;" "Transactions of the Zoological Society:" 1835. As well as in Davidson's "General Introduction," chap. i.: 1853. S. P. Woodward's "Manual of the Mollusca: 1854. But especially to the magnificent memoir by Hancock, "On the Organization of the Brachiopoda," Trans. Royal Soc.: 1858. As well as to Gratiolet's most important and excellent memoir, "Etudes Anatomiques sur la Lingula anatina," in the "Journal de Conchyliogie" for January and April, 1860.

wise shown that the valves of Lingula, when dried at 100 degrees, contain for 100 parts

Organic matter	45·20
Carbonate of lime	6·68
Phosphate of lime	42·29
Ditto magnesia	3·85
Ditto sesqui-oxide of iron	1·98
Silica	traces

This distinguished French chemist observes at the same time that this composition of the test of Lingula approximates to that which M. Chevreuil signalized in the scales of the Lepidostria, as well as to the test of insects, as described some years ago by Halchett.

In the interior of the valves may be seen a number of muscular and other impressions, with which the palæontologist should become acquainted; but it would be out of place were we to enter into a minute anatomical description of

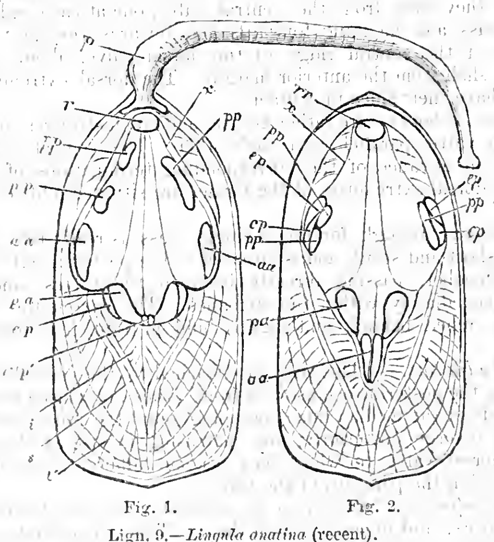


Fig. 1. Fig. 2.

Lign. 9.—*Lingula anatina* (recent).

Fig. 1.—Ventral Valve, Woodward, Hancock, etc.; valve superieure, Gratiolet. Fig. 2.—Dorsal valve, Woodward, Hancock, etc.; valvo inferieure, Gratiolet.

p a, Posterior occlusor, Hancock; = anterior adductors, Woodward; = pré-adducteurs, Gratiolet; = untere schiese muskelbündel, Vogt; = muscles qui vont directement d'une coquille a l'autre, Cuvier. *a a*, Anterior occlusor, Hancock; = anterior retractors, Woodward; = muscles obliques postero-antérieurs, Gratiolet; = mittlere schiese muskelbündel, Vogt. *r r r*, Divaricator, Hancock; = posterior adductor, Woodward; = post-adducteurs, Gratiolet; = oberer schliessmuskel, Vogt. *p p*. Posterior adjustor, Hancock; = posterior retractors, Woodward; = muscles croisè ou oblique transverse, Gratiolet. *e p*, External adjustor, Hancock; = external protractors, Woodward; = surface sur la quelle se prolonge l'insertion du muscle oblique antero-postérieur paire externe, Gratiolet. *c p* and *c′ p′*, Central adjustor, Hancock; = central protractor, Woodward; *c p*, muscles obliques anterieurs paire interne, Gratiolet; and *c′ p′*, muscles obliques antérieurs paire interno et externe, Gratiolet. *x*, Line indicating the posterior parietals, Hancock; = peaussier verticaux, Gratiolet. *p*, Peduncular muscle, Hancock; = capsule of pedicle, Woodward; = muscle interieur du pedoncle, Gratiolet. *i*, Impressions produced by the central branches of sinuses, Hancock. *s*, Impressions produced by the outer or lateral branches of sinuses. *i′*, Impressions produced by pallial lobe.

the animal itself in a memoir exclusively devoted to fossil species. We will therefore briefly place before the reader a few details only concerning those muscles which have left recognizable impressions in the interior of the valves. It must also be observed that although Mr. Woodward, Mr. Hancock, and Dr. Gratiolet and others agree as to the shape and position of the various muscles, they do not interpret the functions of some of these exactly in the same manner, and as a number of names have been applied to designate the same muscle, the first thing to do will be to place before the reader figures showing the position of the impressions and the synonymous terms that have been employed, and such will also save us the necessity of describing these scars, which a glance at the figures will explain far better than could be done by simple words.

The muscular system is much more complex in the unarticulated divisions of the Brachiopoda than in articulated groups; while describing their shape and direction we cannot do better than to follow what has been said by Mr. Hancock in his admirable memoir upon the "Anatomy of the Brachiopoda," published in the "Philosophical Transactions of the Royal Society," 1858.

The *anterior occlusors* "are a pair of stout muscles, of about equal thickness throughout; they pass from the ventral valve, one at each side, in front of the visceral mass, and inclining forwards and inwards, they go to be attached to the sides of the central ridge of the dorsal valve, about one-third the length of the shell from the anterior margin. The dorsal extremities are compressed, and have their sides in contact."

The *posterior occlusors* "are rather stouter and much stronger, and go directly from valve to valve, parallel with each other. The ventral extremities are placed a little in advance of the corresponding terminations of the anterior pair; and the dorsal extremities of the former are situated a little behind those of the latter."

The *divaricator*, "though forming a single mass, is really two muscles combined. It is short and stout, and is situated at the posterior extremity of the perivisceral chamber, passing directly between the valves, and having its attachments immediately within the umbones. The extremities have a semicircular form, arched behind, and slightly bifid in front, indicating its double nature."

The *central adjustors*.—"This pair are attached to the ventral valve by fine points between the posterior occlusors in front; they are placed close together, one on each side of the median line: sweeping round the inner border of these muscles, they diverge posteriorly, and increasing in size as they go, ascend towards the dorsal valve, to which they become adherent, one on each side, immediately within the parieties of the body."

The *external adjustors* "arise from the ventral valve, at the outside of the posterior occlusors, and in contact with them. They are at first pretty stout, but on passing outwards and backwards they enlarge a little, and ascending, are inserted into the dorsal valve, one on each side, immediately behind the central pair."

The *posterior adjustors* "are large and powerful muscles, and though they may be considered as a pair, they are asymmetrical, there being two on one side and only one on the other. As they pass across from valve to valve they intersect each other, the single one passing between the other two. The single one is as large as the other two put together, and is attached to the left side of the ventral valve, about midway between the divaricator and the anterior occlusor. From this point it passes diagonally upwards and forwards, . . and on reaching the opposite side of the dorsal valve has the other end inserted into the latter, immediately within the posterior terminations of the external and central adjustors of the same side. At the points of attachment the three muscles are pressed so close together, that they appear, at first sight, as only

one. The two opposite posterior adjustors take their origin from the right side of the ventral valve, considerably apart; but both of them close to the lateral parietes of the body, one only a little in advance of the divaricator, and the other a short distance further forward. They converge as they penetrate the visceral mass, and sloping forward, one on each side of the single muscle, with the alimentary tube above them, they ascend to their insertion into the left side of the dorsal valve, directly within those of the external and central adjustors. Therefore at this point there are the terminations of four muscles in close contact."

The *peduncular muscle* "has its insertion immediately within the umbo of the ventral valve, and close behind the divaricator."

x is a line indicating attachment of the posterior parietals.

There are some other muscles, but as they do not leave any impressions upon the surface of the shell, will not require to be here recorded; but now that the reader has had the names, shape, and position of the muscles explained, it will be necessary to mention as briefly as possible what are their supposed functions, and for this purpose we will particularly mention the views of Mr. Hancock and Dr. Gratiolet, as they are the authors who have more recently examined the animal with the greatest attention. In order to avoid the possibility of error upon my part, I requested the two last named anatomists to kindly transmit me their views, and which I will now transcribe.

According to Mr. Hancock, the functions of the various muscles might be shortly described as follows:—

"The *anterior* and *posterior occlusors* are mainly instrumental in closing the valves.

"The *divaricators* are the chief agents in opening them. When they contract the umbonal regions of the valves are approximated, and thus pressing forward the fluid in the perivisceral chamber, their anterior margin is separated.

"The primary function of the three pairs of *adjustors* is to keep the valves opposed to each other, or, in other words, to adjust them; and in this respect to compensate for the deficiency of a hinge and condyles. When in full action and in co-operation with the occlusors and divaricator, they likewise assist in closing the valves. The adjustors are the sliding muscles of those authors who believe in the sliding of the valves over each other. The anterior occlusors have had a similar function assigned to them.

The peduncular muscle attaches the shell to the peduncle, and has probably the power of moving the former upon the latter."

Some doubt exists concerning the homology of the adjustor muscles (in Lingula); but Mr. Hancock has not expressed any strong opinion on the point, he thought it likely that the muscles so named in the articulated and unarticulated genera of Brachiopoda were probably homologous, but is ready to admit that he may be possibly mistaken, and, if so, he would not however be disposed to change the names, for in both divisions the function of these muscles is to adjust the valves. It is only necessary to keep in view that they are *not* homologous.

We will now give Dr. Gratiolet's description of the functions of the muscles, and for which I am indebted to the author himself, who has kindly therein distinguished the effects of *simultaneous action* and those of the *alternative action*; and for the assistance of the reader Mr. Hancock's names have been added within brackets.

1.—Muscles Preadducteurs [Posterior Adductor] and Post-Adducteurs [Divaricators].

a, *Simultaneous action.*—The energetically drawing together the valves in their whole length.

b, Alternative action.—When the preadducteurs contract themselves alone, they close the shell in front, and make it gape behind; when the post-adducteurs contract alone, they close the shell almost completely behind, and make it open in front.

2.—Muscles Peaussiers Verticaux [Posterior Parietal Muscles].

a, Simultaneous action.—They depress the body behind, cause the internal fluid to flow towards the arms, and consequently come strongly in aid of the action of the "muscles post adducteurs."

3.—Muscles Obliques Transversalement: Muscles Croises of Cuvier [Posterior Adjustors].

a, Simultaneous action.—They energetically draw together the valves.

b, Alternative action.—Taking for a fixed point the valve, which I call the superior (ventral), the right muscle causing a traction upon the opposite side of the inferior valve makes it deviate a little to the right by a sliding; the extent of which I should not know, *a priori*, how to measure. The double cross muscle of the left side acting symmetrically makes it deviate a little to the left.

4.—Muscles Obliques Postero-anterieurs [anterior Occlusor] et Antero-posterieurs [Central and External Adjustors].

a, Simultaneous action.—They draw the valves together energetically.

b, Alternative action.—Supposing always the superior (ventral) valve as a fixed point, the "muscles postero-anterieurs," acting from behind forward upon the inferior (dorsal) valve, make it slide backward. The muscles "antero-posterieurs," acting from the front backward upon the inferior valve, make it slide forward.

c, N.B.—If one admitted an alternative possible between the longitudinal oblique muscle of the right side and the left side, their movements would evidently come in aid of those of the cross muscles.

5.—Muscles Pedonculaires [Peduncular Muscle] et Muscles Marginaux.

These muscles leave also their traces upon the shell. The first erect (adjust) the body upon the peduncle, and that in two ways; the first by a direct action, in the second place by causing the fluids which fill the internal cavity of the peduncle to ebb into the body. The second act exclusively upon the border of the great pallial lobes.

It will therefore be seen from what has been stated that although anatomists agree as to the shape and position of the muscles, they entertain different views respecting some of their functions. Thus Mr. Hancock objects entirely to the notion of the sliding of the valves in different directions over each other by the aid of the adjustors (protractor sliding muscles of Woodward*), a theory first propounded by Cuvier and Owen; while Dr. Gratiolet believes that the cross disposition of certain muscles, whether from behind forward, or whether from right to left, would lead one to imagine a compensated antagonism, from which equilibrium would result during the simultaneous contraction of all the elements; and that the oblique muscles transversely crossed of Cuvier, his "muscles obliques postero-anterieurs" and "antero-posterieurs" were employed in the sliding action of the valves. Mr. Hancock on the other hand observes that in *Crania*, where the muscular system is arranged after the plan of *Lingula*, there exists *no* sliding movement, and that Mr. Lucas Barrett,

* According to Mr. S. P. Woodward, Lingula would possess a pedicle muscle; three adductor muscles, the posterior pair combined; two pairs of retractors, the posterior pair unsymmetrical, one of them dividing; and two posterior sliding muscles.

who has seen *Crania* alive, has distinctly stated that "The valves open by moving upon the straight side as on a hinge, without sliding of the valves;" but it would be out of place and presumptuous were I to dwell any longer upon this controversed question, my object having been attained if I have been able to lay before the geological and palæontological reader the views of two such eminently distinguished anatomists as Mr. Hancock and Dr. Gratiolet and no doubt time will prove which is the correct interpretation; for now that the question at issue has been made known, it will not be difficult for some observer, who may happen to be where *Lingula* is found alive, to notice whether or not the valves do slide upon one another. We will now conclude the little we had deemed necessary to say of the animal by observing that the oral arms are not supported as in many of the articulated genera by a more or less complicated system of lamellæ; that they are fleshy, with their spires directed inwards towards each other.

After having assembled and compared with much attention a very great many specimens of Scottish Carboniferous Lingula, I could conscientiously admit or distinguish but three—*L. squamiformis, L. Scotica, L. mytiloides*—notwithstanding that palæontologists believe in the existence of a large number.

XLVI.—Lingula squamiformis. Phillips. Pl. v., fig. 30-35.

Lingula squamiformis. Phillips' "Geol. of Yorkshire," vol. ii., pl. xi., fig. 14, 1836, = *L. Portlocki*, M'Coy.

The shells composing this species are longitudinally oblong, one-third, or less, longer than wide, with sub-parallel sides, and broadest towards the anterior extremity; the frontal margin assuming either a very slight inward or outward curve. The anterior portion is gradually curved on either side; the beak being rounded, or but slightly angular at its extremity in the dorsal valve, with a thickened margin, tapering pointed retrally at its termination in the ventral one, which is consequently so much longer than the opposite valve. The valves are slightly convex, but somewhat depressed along their middle. In the dorsal one there exists a small apex close to the rounded margin of the beak, and from which usually radiate three small rounded ridges, separated by shallow sulci. The external surface in both valves is covered with numerous fine concentric striæ, or lines of growth, giving to the shell a beautifully and delicately sculptured appearance, for the minute plications of growth succeed each other with much regularity, while some stronger lines or interruptions in growth are produced at variable distances. The internal muscular impressions are well defined in some specimens, especially those produced by the occlusor and external adjustors of Hancock.

This is a common species in certain Scottish carboniferous strata and localities, and can be distinguished from its congeners by shape and sculpture, although the Silurian *Lingula granulata* of Phillips approaches it nearest both in shape and sculpture; this last is, however, usually less elongated, and does not present those radiating ridges, which are generally but not always observable in the carboniferous species. In his work on British Palæozoic fossils, Prof. M'Coy concludes his description of *L. squamiformis* by stating that "the wide, short, oblong form of this species easily distinguishes it from the others in the upper Palæozoic rocks, the more elongated narrow oblong species, well figured in Portlock's 'Geological Report,' tab. 32, fig. 5, under this name, might be called *L. Portlocki* (M'Coy), its proportional width is only 55-100th in the long, and 60-100th in the short valve;" but specimens connecting the narrow and the wider varieties are so numerous that I could not admit the two extremes as distinct species, besides which, Phillips' original example is perfectly similar to many of the Scottish examples of the species, but was not very

correctly figured in the "Geology of Yorkshire," and may thus have led some to doubt the identity. Phillips' specimen, which may be seen in the British Museum, and of which I possess a beautiful drawing, for which I am indebted to my valued and distinguished friend, Mr. S. P. Woodward, consists of a shell and counterpart, or rather the shell is equally divided between the two sides of the split nodule, so that neither of them show the true structure. When the shell is removed, the matrix shows regular concentric striæ, similar to those above described, but elsewhere only fractured lines of laminæ and radiating striæ. The nodule is black, and the shell dark and pyritous: it will be figured in my larger work. Some Scottish examples of *L. squamiformis* have attained thirteen lines in length by eight and a-half in width, but the generality of specimens are smaller, and the shell is very often found enclosed in ironstone nodules.

In Lanarkshire it occurs at Raes Gill, at three hundred and forty-one fathoms below "Ell coal;" three hundred and forty-three at Hall Craig; three hundred and seventeen at Braidwood Gill; three hundred and fifty-four at Langshaw Burn; it is found also at Hall Hill, near Lesmahago. In Renfrewshire, at Orchard-quarry, Thornliebank. In Dumbartonshire, at Netherwood, near Castlecary. In Stirlingshire, in the Mill Burn beds, Campsie main limestone, and Corrie Burn beds. It is also found at Bishopbriggs, three miles north of Glasgow. In Haddingtonshire, at Cat Craig, near Dunbar. In Edinburghshire, at Wardie (Western Breakwater, Granton); and occurs also in Bute, Fifeshire, and the Berwickshire coast.

XLVII.—Lingula Scotica. Davidson. Pl. v., figs. 36-37.

This shell is of an elongated triangular shape, tapering at the beak, slightly rounded laterally and in front. The valves are slightly convex, but much compressed, while the entire surface is covered with numerous minute concentric striæ, with still wider flattened interspaces. This remarkable species is easily distinguished by its triangular shape and tapering sides and beaks, as well as by the delicate sculpture which adorns its surface. In shape it approaches to certain exceptional examples of Phillips' *Lingula cuneata*; but the Carboniferous and Silurian species cannot be confounded.* *L. Scotica* is perhaps the largest Scottish Carboniferous species of the genus hitherto discovered, for several examples have measured fifteen lines in length by twelve and a-half in width; and a fragment in the Museum of Practical Geology would denote still larger proportions. The interior has not been hitherto discovered; but upon an internal cast obscure Lingula-like indications of occlusor muscular impressions could be perceived.

This Lingula occurs at Gare, in Lanarkshire, at two hundred and thirty-nine fathoms below the "Ell coal," and from which locality it has been known to a friend in Carluke for upwards of thirty years.† My attention was, however, first directed to the shell by Mr. Young, who had been struck by its peculiar triangular appearance, and it was subsequently discovered at Robroyston, north of Glasgow, in beds upon a similar horizon to that of Gare, while the largest examples were procured by Dr. Slimon, from Hall Hill, Auchenheath, and Coalburn, Lesmahago, about three hundred fathoms below "Ell coal."

* I possess also an American Lingula from the Pottsdam sandstone of the Falls of St. Croix, Minnesota, which is stated by Mr. Worthen to be the oldest known American species of the genus. In shape it is very similar to *L. Scotica*, but differs from it in sculpture as well as in the convexity of its valves.

† This shell has been known for many years in Scotland as a Posidonomya, but of which genus it does not possess the character.

XLVIII.—Lingula mytiloides. Sowerby. Pl. v., figs. 38-43.

Lingula mytiloides. Sowerby, "Min. Con.," tab. xix., fig. 1-2, 1813, = *Lingula elliptica* and = *L. parallela*, Phillips' "Geology of Yorkshire," vol. ii., plate xi., figs. 11-15 and 17-19, 1836.

This shell appears to vary in shape, but is usually more or less regularly elliptical or ovate, with its greatest width either towards the posterior or anterior extremity. Its sides are also sometimes nearly parallel and rounded in front, but both front and beaks are in other examples about equally and regularly elliptically attenuated. The valves are generally convex, and most elevated along the middle, where there exists likewise a flatness, which becomes gradually wider as it extends from the apex of the beak to the front, the lateral portions of the valves sloping rather abruptly on either side, while the surface is marked at intervals by a greater or smaller number of concentric lines or ridges of growth. The shell under description has been referred to Sowerby's *L. mytiloides,* because several of the specimens were exactly similar in shape to those figured by Sowerby, in 1813, and from it having appeared that *L. parallela* and *L. elliptica* were only slight variations in shape of the Sowerby shell (?). Some palæontologists will however, differ with me in this conclusion, and may prefer retaining *L. mytiloides* and *L. parallela* as separate species, and I should be glad to adopt their views if they can point out the characters by which the two can be distinguished.* *L. mytiloides* has usually a glossy appearance, and was probably when alive of a bright green colour; it is also a common Scottish species.

In the parish of Carluke, in Lanarkshire, it occurs in the slaty ironstone, at one hundred and sixty fathoms below the "Ell coal;" two hundred and thirty-nine at Gare; three hundred at Mashock Burn; three hundred and thirty-seven at Raes Gill, Braidwood, and Langshaw Burn, etc.; three hundred and seventy-one at Kilcadzow. It occurs likewise at Hall Hill, near Lesmahago; Capel Rig, East Kilbride; Calderside and Auchentibber, High Blantyre; Bishopbriggs and Robroyston, north of Glasgow. In Renfrewshire, at Orchard-quarry, Thornliebank. In Ayrshire, at West Broadstone, Beith. In Stirlingshire, at Craigenglen, and Corrie Burn. In Fifeshire, at Craig Hartle, etc. It has also been found along the Berwickshire coast: and at Marshall Meadows, three miles north of Berwick, a very elongated variety has been discovered by Mr. Tate, and for which he proposes the designation of *L. elongata.*

XLIX.—Spiriferina laminosa. M'Coy. Pl. v., figs. 8-9.

Cyrtia laminosa. M'Coy, "Synopsis of the Carb. Fossils of Ireland, p. 137, pl. xxi., fig. 4, 1844. *Spirifera id.,* "Dav. Br. Carb. Mon., pl. vii., figs. 17-22.

This form is generally sub-rhomboidal, with convex valves, the lateral portions of the shell being regularly curved, with acute cardinal extremities: the hinge-line is as long as the greatest width of the shell. The area large, triangular, and divided by a fissure of moderate width. The beak is small, and not much produced above or beyond the level of the area. The mesial fold in the dorsal valve is broad, more or less elevated, and without ribs, while the sinus in the ventral valve is wide, and of moderate depth; there exists also on the lateral portions of each valve from sixteen to twenty narrow radiating ribs, intersected by closely disposed, sharp, concentric, undulating laminæ.

This species evidently exists in Scotland, although no perfect example with

* At page 368 of his History of British Animals," while describing *Lingula mytiloides*, Dr. Fleming refers to Ure's plate xvi., fig. 5, as probably belonging to the species in question, but I am convinced that this is a mistake, as the shell there represented is far from resembling any Lingula with which I am acquainted.

its shell entirely preserved has hitherto come under my direct observation; fragments showing the beautifully sculptured surface may be seen in the Museum of Practical Geology, and which are stated to be from coraline limestone north of St. Monace, in Fifeshire, and some casts have been likewise obtained by Mr. Tate, at Lammerton, in argilaceous sandstone, a little above the Lammerton coal, and of which a specimen will be found represented upon our plate, as well as a fragment of shell showing the sculptured surface. *Sp. laminosa* has some points of resemblance to *Spiriferina cristata*, var. *octoplicata*, but it is readily distinguished by the greater number and comparatively smaller ribs, as well as by other peculiarities.

We have now completed our catalogue of the Brachiopoda hitherto discovered in the Scottish Carboniferous system; and although the results of our researches are no doubt very imperfect, and that the subject will require a far more lengthened investigation, still every effort has been made to lay before the reader as complete a monograph as the material and observations at present assembled would permit. Time and continued researches will no doubt enable palæontologists to correct the errors here inadvertently committed, as well as to determine those points which we have unavoidably left as unsettled, or provisional, and especially so with reference to some few forms, of which we did not possess sufficient material.

The Scottish Carboniferous strata have therefore furnished us with about forty-nine or fifty species, among which may be noticed many of the most general and characteristic forms of the system; but many other species that are common in England and Ireland have not been discovered in our Scottish strata, among these we may mention *Spirifera striata*, *S. Mosquensis*, *S. planata*, *S. triangularis*, *S. convoluta*, *S. cuspidata*, *S. distans*, *S. triradialis*, *S. integricosta*, *Cyrtina septosa*, *C. carbonaria*, *Athyra expansa*, *Rhynchonella acuminata*, *R. reniformis*, *R. flexistria*, *R. angulata*, *Chonetes comoides*, *C. papilionacea*, *Productus striatus*, *P. sub-lævis*, *P. plicatilis*, *P. humerosus*, *P. tessellatus*, *P. margaritaceus*, etc. Although I have no expectation that our Scottish list will ever be very materially increased, still with diligent search a few more species may perhaps in time be added to those with which we are at present acquainted.

Belgium is very rich in Carboniferous Brachiopoda, and possesses a certain number of species that have not been discovered in Great Britain; and with the view to ascertain which were common to Scotland and to that country, I furnished Prof. de Koninck with a list and figures of our shells, and requested him at the same time to arrange our species which were found also in Belgium into his respective faunas of Visé and Tournay, and have been favoured with the following tabular view:—

Species Peculiar to Vise.	To Tournay.	Species Common to the Two Faunas.
1. *Terebratula succulus.*	1. *Spirifera pinguis.*	1. *Terebratula hastata.*
2. ——— *vesicularis.*	2. ——— *Urii.*	2. *Spirifera lineatis.*
3. *Spirifera duplicostus.*	3. ——— *laminosus.*	3. ——— *insculptus.*
4. ——— *bisulcatus.*	4. *Athyris Royssii.*	4. *Athyris plano-sulcatus.*
5. ——— *trigonalis.*	5. *Crania quadrata.*	5. *Retzia radialis.*
6. ——— *ovalis.*		6. *Rhynchonella pugnus.*
7. ——— *glabra.*		7. ——— *pleurodon.*
8. ——— *cristatus*, var. *octoplicatus.*		8. *Strophomena rhomboidalis*
9. *Athyris ambigua.*		9. ——— *crenistria.*
10. *Camarophoria crumena.*		10. *Orthis resupinata.*
11. *Chonetes alternata* (our Hardrensis).		11. ——— *Michelini.*
12. ——— *Buchiana.*		12. *Productus cora.*
13. *Productus giganteus.*		13. ——— *semireticulatus*
14. ——— *latissimus.*		14. ——— *costatus.*
15. ——— *carbonarius.*		15. ——— *scabriculus.*
16. ——— *longispinus.*		16. ——— *punctatus.*
17. ——— *undatus.*		17. ——— *aculeatus.*
18. ——— *pustulosus.*		18. ——— *mesolobus.*
19. ——— *fimbriatus.*		
20. ——— *spinulosus.*		

Prof. de Koninck further observes that out of our forty-nine Scottish species, twenty belong exclusively to his fauna of Visé, five only to that of Tournay, while eighteen would be common to the two, but that he does not know where to locate my *Productus Youngianus*, *Spirifer Carlukiensis*, and *Lingula Scotica*, as they have not been found in Belgium, nor does he know where to place the *Lingula squamiformis*, *L. mytiloides*, and *Discina natida*, so that in a general way some thirty-eight or forty of our species have been found at Visé, while twenty-three occur also at Tournay.

It may likewise be observed that although some of our Scottish species might vie in size with those of England and Ireland, yet as a general rule Scottish shells of the Carboniferous period are much

smaller,* but not the less interesting on that account, and are in many instances far more perfectly preserved than any similar species hitherto noticed from other countries, so that we have been enabled in several instances to complete the descriptions of the characters both internal and external, which were but imperfectly made out in our larger work. In a very interesting paper by Mr. McAndrews on the comparative size of marine mollusca, it is clearly proved that "although the size attained by mollusca may be influenced by various conditions in different localities, as a general rule each species attains its greatest size, as well as its greatest number in the latitude best suited to its development." Much has, however, to be learned relative to the habitats and distribution of the British Carboniferous species, and correct lists of those peculiar to each horizon, zone, or stage, have still to be drawn up, as well as those that partake of a larger or more restricted vertical range; and indeed, when preparing my monograph for the Palæontographical Society, I found that the information I could obtain upon this very important subject was so scanty, and often so unsatisfactory and contradictory, that I was obliged to confine myself almost entirely to the working out of the species, which had themselves been thrown into much confusion, on account of the multitude of erroneous identifications or mis-naming prevalent in almost every British public and private collection, while the nomenclature was likewise most heavily burdened with a vast number of synononious and useless denominations. It could not, therefore, be expected in most instances that local enquirers could furnish that correct information relative to the distribution of the species in their particular districts until they had become familiar with the characters of the species themselves; it would have to a certain extent been just as if we were to expect that a person could read fluently who was but very imperfectly acquainted with the name and shape of his letters; but it is to be hoped that before long that important information will be forthcoming, and which no one could furnish or work out so well as those who reside in the localities where the fossils are found. The difficulty and perplexity I so often experience in the identification of specimens and species should deter many who may be even less experienced than myself from too hastily supposing that a shell which may not be familiar to their eye is really new; for in order to ascertain whether a species is in reality so, a very considerable amount of research is required, a research many cannot undertake, from the want of books or means of comparison. I would, therefore, urgently impress upon the minds of young palæontologists the very great importance of caution, and not too hastily or highly consider as new what they might not be acquainted with, otherwise the science will become so burdened with synonyms and useless denominations that it will deter many from

* Conditions arising from food and climate no doubt modify form and size, and modifications of form not amounting to malformation might arise from diseased condition.

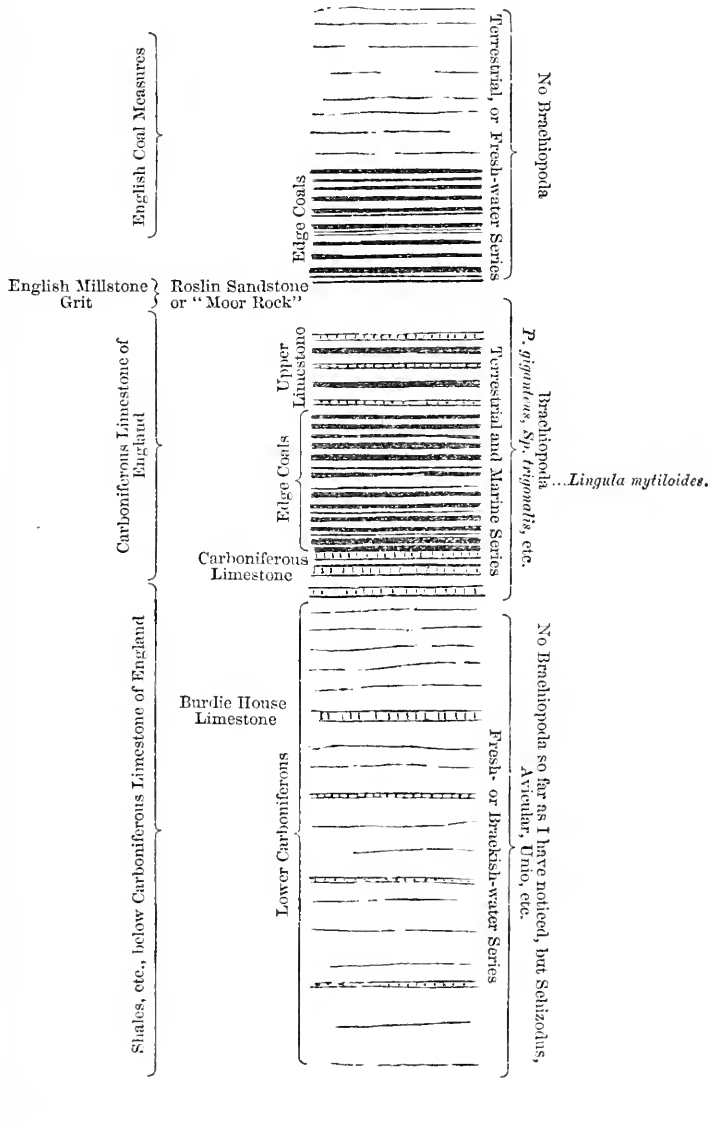
prosecuting a study which would from its complication have lost all those charms which Nature lays open to the studious mind.

A correct section of the British Carboniferous System, with a list of the species peculiar to each zone or stage, as well as of those which pôssess a greater vertical range, is, as we have already stated, a great desideratum, and is a subject well worthy of the attention of the geologist and palæontologist. Such an investigation is being carried out by Doctors White and Oppal, Prof. Suess, Mr. Eugene Deslongchamps, and others with reference to the Jurassic strata; and the others systems have been likewise to a greater or lesser extent similarly investigated; but the Carboniferous one (which is so far spread and so important) appears to have been in reality less completely and carefully studied with respect to the distribution of its species than almost any other; although we possess many valuable works by several of our most eminent geologists and palæontologists in which the system and fossils have been minutely described. Two great helps which recent species afford are almost entirely precluded from the palæontologist, that is to say, the power of being able to anatomically examine the animal, and the absence of that coloration which is often of so much assistance in the discrimination of recent shells; and when we reflect how vivid, beautiful, and varied must have been the tints which once adorned the now black and dingy fossil, we are delighted when, by some fortunate accident, some remains of that colour is faintly preserved upon a shell which has, for almost countless ages been concealed from the sight of man. The interiors and well preserved internal casts should likewise be carefully collected, for upon them are impressed many signs which can be interpreted by the experienced palæontologist, and lead him to reconstruct and describe many characters in an animal of which no living representatives may at present exist.

In the first pages of this paper, we endeavoured to give some brief and general idea of the principal divisions into which the Carboniferous system had been divided, as well as some details regarding that of Scotland in particular. Since then, Mr. Geikie, of the Geological Survey of Scotland, has kindly transmitted to me the annexed tabular view of the Carboniferous series of the Lothians, and which appears to be nearly the same as in the western districts. In the Lothians, the Brachiopoda range only in that portion of the system, or section, which corresponds to the Carboniferous limestone of England, some species ranging from the top to the bottom of this division, but the greater number appear confined to the lower limestone series. *Lingula mytiloides* is stated by Mr. Geikie to be in the Lothians characteristic of a zone about the middle of the Edge Coal series; but more information may be expected as soon as the Survey shall have published the results of their careful and assiduous labours.

Mr. George Tate, whose knowledge of the Carboniferous system is well known, has, at my request, favoured me also with a note upon his "Tweedian group," which we will here transcribe, as it will explain the views of that excellent observer, as developed relative to some of the oldest beds of the system in Berwickshire and Northumberland.

TABULAR VIEW OF THE CARBONIFEROUS SYSTEM IN THE LOTHIANS.



"The Greywacke rock, now the Cambrian system of Sedgwick, or Lower Silurian of Murchison, forms the Lammermuir Hills, which range through Berwickshire from east-north-east to west-south-west. On these rocks rest unconformably the upper beds of the Old Red Sandstone, which again are conformably overlaid by the Carboniferous formation. The beds of this formation in Berwickshire are connected with those of Northumberland, and then, we find it distinguishable into four groups, which thus succeed each other in descending order: "1, The Coal-measures; 2, Millstone Grit; 3, the Mountain-limestone; 4, the Tweedian-group.

"1 and 2. Neither the Coal Measures nor the Millstone-grit extend into Berwickshire; but it may be here observed that the term Coal Measures is objectionable, because both the Millstone-grit and the Mountain-limestone contain coal-seams, though not so thick, so good in quality, or so numerous, as in the Newcastle Coal-Field.

"3. The Mountain-limestone spread over a large area in Northumberland, but a few only of the lower beds appear in Berwickshire, and they form a very small portion of the county. On the south side of the Lammermuir they occupy a narrow strip along the coast, from the mouth of the Tweed to a little beyond Lammerton Sheil, and on the north side of the range they overlie the Tweedian group from the Cove harbour at Cockburnspath to the northern extremity of the county at Dunglas Burn. Brachiopods and other fossils, characteristic of the mountain-limestone, occur in these beds.

"4. In 1856* I applied the term, "Tweedian-group" to a series of beds lying below the Mountain-limestone. They form, as I then stated, the lowest portion of the Carboniferous formation, lying below the Productal and Encrinal Mountain-limestone of Northumberland and Berwickshire. They consist of grey, greenish, and lilac coloured arenaceous shales, interstratified with sandstones usually yellowish or white slaty sandstone, and thin beds of argillaceous and magnesian limestones. Lepidodendra, coniferous trees, and Stigmaria fucoides occur in some parts of the group, but there are no workable seams of coal. Scales and remains of fish, Modiolæ and Entomostraca are tolerably abundant in some beds: but at Tweed Mill, species of Orthocerata and Pleurotomaria are associated with coniferous trees. The group is specially marked by the absence of Brachiopoda, which are very abundant in the overlying mountain-limestone—generally freshwater or lacustrine conditions are indicated: there is no evidence of a deep sea deposit, and in the rare instances where we find undoubted marine remains, they are accompanied with land plants, which show that the deposit was formed in a shallow estuary.

* Transactions of Berwickshire Club, vol. iii., p. 172.

(To be continued.)

THE GEOLOGIST.

JULY, 1860.

THE GEOLOGY OF THE SEA.

By S. J. Mackie, F.G.S., F.S.A.

No man is right at all times, says the common proverb, and Geologists are not always exceptions to the rule. Granite has been looked upon as the "back-bone" of the earth's crust, and fire or deeply-seated internal heat has been supposed to have fused an ancient unknown kind of rock into its present compact and crystalline state, while although now scarcely anything more than, at most, hot water will be allowed as an agent in the structural change. The older geologists invoked on all occasions when great effects were to be produced most terrible commotions and catastrophes, just as melo-dramatists bring in blue fire and demons. Nature is, however, a most methodical business personage. Sedate and steady, she takes quietly and methodically everything with which she has to do, and keeps her accounts properly by double entry. If you draw on her on the one hand, immediately she pays into her bankers on the other. Nothing goes down on the one side of her accounts but instantly she makes some entry on the other.

If the sea now-a-days is *salt*, depend upon it "Old Ocean" is charged for that material somewhere in Dame Nature's ledger.

This, perhaps, is a humorous way of getting at a curious question. I have been asked it more than once, and being asked has often set me thinking—

Was the sea always salt?

I put the question by itself, and having put it, there I leave it. I do not even say that I shall answer it; but as I have sometimes thought about it, what I have thought, and so far as I know what others have thought about it, I will just put down, as much, perhaps, for the benefit of the reader as my own.

Let us go back at once to the time when the dry land first appeared. Was it the "salt sea" then as now? Or were its waters fresher, salter, or of other kind? Were the waves as rough as in our own stormy seasons, the winds as variable or as strong before the first snow-flakes fell as they have been since? Did those winds in sportive play catch up into the dry air the dust-grains pounded by battering breakers from the adamantine rocks, and strewn along the shores? Was the waste of land by sea and air as rapid then, or faster, slower than its present perishing and degradation? Were the mechanical actions, now most active, as active then, or were chemical changes quicker then or more assistant to the attritive powers?

Is this to get into dreamland? Are we rivalling the baseless visions and imaginings of the old physicists in such inquiries? Or are they real sensible queries which it is the business of science to answer?

Harder questions have been put for scientific solution, and have been answered; simpler, and not answered yet.

No man must study geology without a bold heart and patient endurance; he must be a good soldier in the cause of science, or he is unfit for a geologist. With old and deep-rooted prejudices to combat; with doubts, and contradictions, and ancient fallacies to do battle against; himself often on weak and slippery grounds, he must be beforehand prepared for many reverses, many changes of positions, many retreats and abandonments of theories and deductions, content alone in looking forward to the elimination of truth in the end, and regarding every defeat as a victory, if it lead him to higher grounds of advantage and securer positions of future progress. Many modifications of former theoretical conclusions have already taken place, and more *must* follow.

The natural method of investigating ancient physical phenomena, and of considering their results and effects by a strict comparison

with present and historically recorded influences, so admirably and widely propagated by the philosophical Lyell, has undoubtedly been carried to the extreme by unreflecting votaries of our science, in the attempt to *identify* the phenomena of remote geological ages with those going on *now* around us. As in chemistry, there are two ways of determining the composition of a substance—*analysis* and *synthesis*—the taking to pieces and the putting together, so in nature there are universally two ways in which physical influences may operate—*separation* and *combination*. One substance liberated by chemical action under one condition may combine with another substance in another condition, and a third element may thus be liberated which might bring another influence into play from which other combinations and other liberations would follow, so that in the endless changes which are capable of thus being effected, we might in the lapse of time find Nature still adhering to *fundamental physical laws*, but working in quite an opposite, or at any rate a very different, manner, to the *identity* thoughtlessly or in the heat of enthusiasm anticipated or presumed.

But to return to our first question. Was it the briny ocean that ebbed and flowed around the primordeal gneissic island-tracts, and washed and triturated the sand-granules and clay-atoms of the "Bottom-rocks," which formed their strands?

To set methodically to work to answer this we must begin at the beginning; we must get, if we can, at some idea of what the first crust of the globe was like, and what first produced the sea. One man of high note as a geologist and chemist has done something for us on the first point. Mr. Sterry-Hunt, a gentleman connected with the Geological Survey of Canada—a country where the greatest development of those old primitive rocks is displayed—has made use of the opportunities of his vocation to investigate the chemical conditions of those most ancient known strata, and has given us as a conclusion of his researches, that in the primitive crust of our planet "all the alkalis, lime, and magnesia must have existed in combination with silica (quartz) and alumina (clay), forming a mixture which, perhaps, resembled dolerite, while the very dense atmosphere would contain in the form of acid-gases all the carbon, chlorine, and sulphur, with an *excess* of oxygen, nitrogen, and watery vapour." These

deductions are of course based upon chemical data; and whether we accept them literally or not, it is probable that something very like this state of things did exist at the remote period referred to, and we may therefore accept them as data to proceed upon.

Next, then, comes the question how the first sea was formed? Naturally, we should think, in the sequence of events incident on the natural refrigeration or cooling of our planet. After the consolidation of the first crust of the globe, we should naturally expect that the condensation of the atmospheric vapours should succeed. Hence, the first rain-fall should have produced the first ocean. Was the first ocean, then, of fresh water? Wait a while. Let us look at both sides of the case; for this rain-fall, perhaps long continued, must have fallen, if our assumption be right, on what would be practically a globe of dolerite. And what, then, would be the result?

Mr. Sterry-Hunt will help us again. He will speak, perhaps, in the concise language of science—a language unintelligible often to the mass, because it is a "short-hand," so to express it, which presumes and requires a considerable amount of knowledge on the part of the reader, but which, in the sentence we shall quote, is, we think, sufficiently intelligible to all.

"The first action," says the investigator referred to, "of a hot *acid* rain falling upon the yet uncooled crust, would give rise to chlorides and sulphates with the separation of silica; and the accumulation of the atmospheric waters would form a sea charged with salts of soda, lime, and magnesia."

Chemical deductions carried still further bring us to another stage. "The subsequent decomposition of the exposed portions of the crust"—those not covered by the primeval ocean—"under the influence of water and carbonic acid, would transform the felspathic portions into a silicate of alumina (clay) on the one hand, and alkaline bi-carbonates on the other; these decomposing the lime-salts of the sea, would give rise to alkaline chlorides and bi-carbonate of lime, the latter to be separated by precipitation, or by organic agency, as limestone."

In this way, then, we arrive at the continued formation of chloride of sodium, or common salt, in the sea, as also of the manner in which the siliceous (flinty-sandstones, quartz-rock, &c.), calcareous (lime-

stones), and argillaceous (clays, shales, &c.) ingredients of our earth's crust were generated.

We are now brought to that age of remote granitoid or gneissic rocks which are the oldest presented to us at this hour of the ancient primeval strata. These, as it is as well to call by a general name, we shall term by their Canadian title of "Laurentian." These are the rocks which constituted the first dry land above the water—at least are the oldest rocks of which any traces remain.

Now gneiss, in broad terms, may be stated to be regenerated, or at any rate modified granite. Its constituent minerals are the same; the like three ostensible substances are there—quartz, felspar, and mica. Quartz, one need scarcely say, is one form of silex, or flint; and mica is a compound of alumina, silica, potash, iron, and fluoric acid. It is, however, the felspar which possesses the chief interest in our present speculations. Felspar has an alkaline base, either soda or potash. Naturally, therefore, felspathic rocks are primarily separated into two sorts—soda-felspar and potash-felspar; the other alkali, the volatile ammonia, while linking itself with clays and argillaceous earths not entering into any combination, affording a felspathic product of the two bases, soda and potash, as they occur in granitic and gneissic rocks; the former only exists in a soluble state, the potash in its combination producing an *insoluble* result.

No one could describe every purpose and all the phases of even any ordinary object at once, and still more to do so properly we must devote something to other objects to which it may be perhaps even only remotely related, or with which it may be only casually associated.

If we selected a watch, for example, it would not be sufficient to explain that it was an instrument for measuring time, on the principle of an uncoiling spring checked in its rate of unfolding by a little toothed bar of steel; the inquiring mind would naturally ask for further explanation, and we should thus be led into mechanics to explain the principles of the action of the mechanism; into metallurgy and jewellery to explain the value and requisites of the materials employed; we should be carried on to clocks and pendulum-motions; and finally onwards still to the general history of the methods of measuring the passage of time, from candle-burning and

sand-running to modern chronometers, lever-watches, and to the delicate *bijoux* not larger than shillings, manufactured at this day in the famous old city of Geneva.

So it is in investigating any one subject of geological history. So mingled do we find it, so associated with other topics, as to be only unriddled or comprehended by very extensive and very different investigations.

Look at that little rill issuing from the base of the chalk-downs, and trickling onwards to the green meadows, That rill has filtered through the chalk-rock, and few of us need a chemist to tell us that the crystal-looking water contains a large amount of chalky matter, for the evidence is plain in the incrustation of the bits of sticks and other objects in its rippling course; but still we want the chemist's art to know that it is carbonic acid gas which enables the water to dissolve out that chalky matter from the solid hills, to hold it in solution, and that it is when the water liberates some portion of that gas into the atmosphere that the water becomes incapable of sustaining the whole of its chalky load and the encrusting sediment is deposited.

So other waters and other springs issuing from other rocks, and in other countries, contain other materials in solution according to the nature of the substance they permeate, as witness the natron-lakes of Egypt, the carbonate of soda springs of Carlsbad and Vichy, the siliceous waters of the geysers, and the ordinary calybeate and medicinal springs.

Now for ages upon ages throughout all time since the dry land has peered above the sea has the percolation of water and the issuing of springs taken place; from the hour when the first rain-drops fell unto the present have the dissolving and re-combining, the undoing and re-forming processes been going on. What has been taken from one place has been carried to another. What has been taken from the land has been given to the sea.

When we consider all the vast amonnt of clays mingled with the other strata in the earth's crust has been originally derived from the decomposition of the felspathic minerals of the old gneissic rocks, we perceive by comparison at once the importance of the part which the alkaline carbonates formed in the decomposition of the alkaliferous

silicates or felspars must have played, as they still continue to do, in the chemistry of the sea. Hence the analyses and study of the percolating waters of the remaining areas of those ancient gneissic and bottom-most sedimentary rocks must be one of the chief points in the elucidation of our question, Was the sea always salt?

Another point of interest still remains, namely the study of the *present constituents* of those old primeval rocks. If water dissolves out certain substances from them, and the dissolution has been going on for ages, it follows there must be a diminished quantity or absence of certain soluble materials, and by consequence a propertionate predominence of insoluble, in the residue of which their present constitution consists.

The yellow corn waves its golden seed-bearing spikes in the summer's breeze, and the harvest is reaped and stored into barns; but the farmer in the inclement days of winter spreads his fields with manure, and ploughs and furrows the soil, opening and turning it up to the rain, the frost, and the air.

And why? To replace that which the corn has extracted, and that the elements in their chemistry and powers may manipulate fresh substances required for another crop.

If we analysed the soil before the crop was grown, would it be the same as after the crop was reaped? Assuredly not, so if we analyse the ancient rocks after ages of loss of certain original ingredients by the incessant dissolving action of percolating springs, they would shew, as we have remarked, a poverty of some substances and a superabundance of others. Thus it is that while we find the potash small in quantity in alkaline and saline waters, we find it locked up in superabundant proportion in orthoclase and other indissoluble forms in the constituent rocks of the earth's crust, while soda, which we find abundant in alkaline and saline springs, is observed gradually to diminish in quantity from the oldest granitic and gneissic rocks through their regenerated materials in the paleozoic, secondary, tertiary, and recent eras, becoming less and less as their periods of formation approach our own.

These conditions and results are readily and mutually explained by the soluble substances found in mineral-bearing waters, and by the actual constitution of the residue of the rock-mass. So the double-

entry in Nature's accounts satisfies us of the correctness of our conclusions; and we must always find the double-entry if we wish to verify our speculations—they are of no reliance without.

Now the springs issuing from clay strata are characterized by a predominence of bi-carbonate of soda with the bi-carbonate of lime and magnesia, for the atmospheric waters charged with carbonic acid gas, in percolating the rock-masses, remove the soda, the lime, and the magnesia, leaving behind the silica, alumina, and potash; and as the clays become more and more sandy and permeable, the action of the filtering waters will be greater, while the finer and compact clays resisting the penetration of water, will retain their soda, lime, and magnesia. On these principles the chemical composition of the ancient sediments must have been throughout all geological periods constantly changing, and hence it is when we examine the constituents of the ancient rocks, we find them, where preserved under favourable circumstances, containing *much* soda, the reverse of which is observable in similar more modern formations; and ancient as are those old Laurentian rocks, they were doubtless derived from the ruins of other rocks in which the proportion of soda was still greater.

And it is from the detritus of the felspar-constituents of those old primitive rocks all over the globe that, from the paleozoic era to our own, the alkaline waters have been derived by which the rock-constituting silicates have been carried down to the sea in the form of carbonate of soda to be transformed by the chloride of calcium (lime) parting with its chlorine into the chloride of sodium, or common salt, while the carbonic acid was liberated from the soda to combine with the calcium, whence the formation of carbonate of lime in the same water, the mechanical deposition and segregation by organic agency of which have given rise to the great masses of limestones we find intercalated at various epochs with the other strata of the earth's crust.

Out of this investigation we derive another conclusion on another point, namely, that the decomposition of rocks is much less rapid *now* than in primeval times, because the soluble soda-silicates are less abundant, and because the quantity of carbonic acid, so powerful an agent in these changes, has been diminished by the formation of various limestones and of coal.

Let us in conclusion examine the nature of the waters which now impregnate the great mass of lower palæozoic strata in Canada. According to Mr. Hunt in them "only about one-half the chlorine is combined with the sodium (common salt), the remainder exists as chlorides of calcium and magnesium, the former predominating, while the sulphates are present only in small amounts."

Comparing the composition of these waters, which may be regarded as representing that of the ancient palæozoic sea, with our modern ocean, we find, as we have already theoretically inferred, that the chloride of calcium (lime) has been replaced by common salt (chloride of sodium), a process involving the presence of carbonate of soda and the formation of carbonate of lime.

Let us now finally return to our question, Was the sea always salt? If what we have deduced be correct, we may answer that the first ocean was one highly charged with various salts, chiefly chlorides of calcium and magnesia; that, with the continued action of atmospheric waters bringing down carbonate of soda to the sea, a chemical process has been constantly carried on, by which the chlorides of calcium and magnesia have been gradually but continuously diminished, and the quantity of chloride of sodium, or common salt, proportionately increased, and consequently that the saltness of the sea is greater now than in its ancient state, and has been constantly increasing from the remotest times unto our own.

ON THE GEOLOGY OF THE STONESFIELD SLATE AND ITS ASSOCIATE FORMATIONS.

BY WILLIAM S. HORTON, OF LIVERPOOL.

There are, perhaps, few spots richer in the "time-hallowed memories of the past" than the old town of Woodstock, near Oxford. In its immediate neighbourhood once stood a royal palace, where, as the readers of Scott will doubtless remember, many of the scenes in one of his novels are laid. The site of this ancient fabric is now occupied by the more stately pile of Blenheim, the princely residence of the Duke of Marlborough. In the park there is a spring still termed, in allusion to the legend more or less familiar to all students of Eng-

lish history, Rosamond's well. At the distance of a few miles only, memorials of our Celtic ancestors exist in the form of tumuli, embowered among the venerable oaks of Wychwood Forest. It is not, however, our present intention to linger amid the many historical associations of Woodstock, deeply fraught with interest as they are, but proceeding at once to our object, we invite our readers to accompany us in a geological ramble to the village of Stonesfield, situated in its vicinity, at a distance of between three and four miles. By far the most agreeable portion of our road traverses the picturesque slopes and luxuriantly wooded glades of Blenheim Park: leaving these behind, we soon arrive within sight of our destination. As we approach the village we perceive it to occupy the sides and summit of a somewhat elevated ridge of land, and our attention will not fail to be arrested by the numerous precipitous piles or mounds of gray stones surrounding it in every direction, and from long exposure to the weather simulating at a distance much of the bleak and rugged aspect of natural cliffs and storm-beaten crags, but, as we discover in due time, they are in reality the gradually accumulated refuse of the slate pits we design to visit in the course of our excursion. Before ascending the hill into the village, the tourist, especially if at all interested in antiquarian pursuits, may profitably devote a short time to the examination of a Roman villa, although but few traces of it exist beyond a portion of its tesselated pavement, for the protection of which a rude hovel has been erected. This relic of that distant era when Britain was a province of the Roman empire, and this sequestered vale of Oxfordshire, the summer retreat of some wealthy citizen of the "Eternal City," is naturally suggestive of the reflection that the object of our visit to Stonesfield is in order to examine the records of an antiquity so remote, that even the far-receding vista of Roman annals affords no parallel by which a comparison may be instituted—an antiquity so vast that the very existence of the human race furnishes no chronology adequate to express the distance of a period so deeply enshrined in the dim eternity of the past. Let us, then, invoke the aid of geological science, which alone can roll back the strong barriers that have so long walled up the sepulchre of that ancient time, and reveal to its disciples the various mysterious forms and phases of life that prevailed during an age of which the historian takes no cognizance, and whose only archives are engraved on those "tables of stone," some of whose quaint inscriptions and marvellous heiroglyphs, as embodied in the Lower Oolitic rocks of Stonesfield, it is our present task to examine, and as far as practicable to decipher.

Strangers who visit this village almost invariably have one or other of two queries proposed to them by its inhabitants, either "Do you want a few thousand slates?" or "Do you want any fossils?" The products thus alluded to form the principle support of the villagers, and are chiefly obtained from the slaty fissile bed occurring at the base of the Bath, or Great Oolite, that being nowhere developed on so extensive a scale as at Stonesfield, although present in some other

localities, Sevenhampton, near Cheltenham, and Colley Weston, Northamptonshire, is thence denominated Stonesfield Slate. This bed of slate, although not exceeding six feet in thickness, is of considerable local value for roofing-purposes; and, indeed, all over Oxfordshire more or less of Stonesfield Slate may be observed on the roofs of the houses, churches, and other buildings. It contains some pebbles of a rock very similar to itself, which, as Sir C. Lyell suggests, may have been portions of the same bed broken up and subsequently re-deposited, and when first raised is very compact, but after having been exposed to the action of frost, readily divides into thin laminæ, and in that state is dressed with the hammer, and prepared for the market. Unlike its equivalent formation in Gloucestershire, the Slate is not exposed in open quarries, but worked by means of well-like shafts penetrating the overlying Oolitic strata, and varying in depth from thirty to sixty feet, according to the level of the surface-ground. Although the Stonesfield Slate will receive the largest share of our attention, yet these overlying beds, which are, in descending order, the Cornbrash, Forest Marble and Bath Oolite demand a brief notice that perhaps will not be deemed out of place. Below the Stonesfield Slate a ferruginous bed of Inferior Oolite may be observed at the base of the hill in the adjoining parish of Fawler. This, since the time of its discovery (February, 1859), has been largely quarried for iron-ore, and found to contain a considerable per centage of that metal. At a distance of about four miles from Stonesfield, in the same direction, near Charlbury, the Lower Lias was exposed some years since by a cutting of the Oxford, Worcester, and Wolverhampton railway, and yielded some beautiful specimens of *Ammonites planicostatus*, *Pleurotomaria Anglica*, and other Liassic fossils.

The Cornbrash presents itself in this district as a hard, coarse, flaggy limestone, with thin bands of brown marls and clay, and when in a state of decomposition furnishes a valuable soil for agricultural purposes. It may be studied to advantage in the neighbourhood of Witney, more especially at a quarry on the side of the Woodstock road, where fine specimens of *Pholadomya Murchisoni (?)* are abundant, associated with a species of Nautilus *(N. inflatus ?)*, *Ammonites discus*, *A. Herveyii*, and another species too imperfect for identification; also *Terebratula maxillata*, *Cardium dissimile*, *Gresslya peregrina*, and *Isocardia minima*. This pit has also furnished some interesting sea-urchins, *Nucleolites sinuatus*, *N. clunicularis*, and a few finely preserved examples of *Holectypus depressus;* also a solitary specimen of *Glyphia rostrata*, a crustacean allied to the lobster. In addition to the above, from some shallow openings on Curbridge Common have been collected *Trigonia costata*, *T. impressa*, *Lima gibbosa*, *Astarte elegans*, *A. excavata*, *Modiola plicata*, *M. bipartita*, with *Terebratula obovata*, a shell that is very abundant in this locality, and highly characteristic of the Cornbrash, and very rarely a beautiful species of sea-urchin, *Acrosalinia hemicidaroides*. The Forest Marble derives its name from the adjacent forest of Wychwood,

where it is largely developed. Several sections are well exposed at the quarries near the Witney Cemetery, where its upper portion consists of a dark-coloured bed of clay containing *Rhynchonella concinna*, *Terebratula digona*, and *T. maxillata*, with spines of Cidaris, and joints of Pentacrinites. This clay is divided about the centre by a thin band of slaty sandstone, which, although not equal to the Stonesfield Slate for the purpose, is capable of being worked by the hammer into a rough kind of roofing-tile. This Forest Marble slate recalls vividly to the mind the condition of the ancient Oolitic sea by whose agency it was formed, the surfaces of many of its slabs being strongly ripple-marked, and covered with the valves of small Ostreæ, Rhynchonellæ, and comminuted fragments of other shells, with here and there a perfect specimen of *Pecten lens*, or *P. vagans*, and occasionally a small sea-urchin, *Diadema depressa*. In one solitary instance the writer was so fortunate as to obtain from one of these slabs a specimen of Acrosalenia, much compressed, but still retaining its long, smooth, pointed spines attached to their sockets, a condition in which Echini are very rarely met with in this or any other formation. These beds of clay and slate are succeeded by a thick stratum of coarse shelly limestone, containing portions of coniferous drift-wood, and but few organic remains of any kind, with the exception of *Lima cardiiformis* and imperfect Terebratulæ. At Stonesfield the Bath Oolite consists of a soft white limestone, succeeded by a stratum of hard compact fissile ragstone passing downward into the true Stonesfield Slate. The upper portion is very fossiliferous, and contains several forms of life which seldom occur in the lower division. These are chiefly some interesting corals *Thamnastræa Lyellii*, two species of *Isastræa*, and some others, associated with a flat species of sea-urchin, *Clypeus Mullerii*, and much more rarely a beautiful Hemicidaris as yet unnamed. This bed also contains a variety of shells, among which may be enumerated *Astarte elegans*, *Terebratula maxillata*, *Nerinæa Eudesii*, *N. melanoides*, *Lima cardiiformis*, and a species of Chemnitzia, *C. Hamptonensis*.

This division of the Bath Oolite may also be studied at Witney, where it has yielded some interesting fish remains identical with those of the Stonesfield Slate. At Minster Lovel, and other places situated on the Cheltenham road, many cuttings have been made in this formation, chiefly for the purpose of procuring road-stone, for which it is, however, but ill adapted. A quarry situated by the road side, near the Minster turnpike, has furnished some instructive specimens, chiefly the palatal teeth of fishes, with fragments of bone and scales; these are found in an insulated condition, and are confined to a thin stratum of brown friable marl, forming the summit of the section.

The second division of the Bath Oolite, both in lithological composition and organic remains, is so nearly allied to the underlying slate that we shall prefer studying them in connection with each other, and regard them both as belonging to one and the same period, rather than treat of them as two separate and distinct formations. A com-

plete list of the fossils of these beds has not yet been formed, probably because there is no complete collection of them in existence. Perhaps the Oxford Geological Museum contains the finest series, chiefly collected by the late Dr. Buckland, who paid frequent visits to this village, and with whose memory the formation under review, rendered classic by his labours and fame, will ever be associated.

Let us now proceed to glance at these products of the slate-pits, and it will be seen that they comprise a marvellous variety of organic remains; for, besides plants, insects, reptiles, and mammalia, indicative of dry land, the crustacea, shells, and predaceous shark-like fishes of the Oolitic ocean are likewise represented in the catalogue.

We begin with plants, and notice one marine form, a branching fucoid, or sea-weed, *Halymenites ramulosus*. Among the ferns that once flourished on that ancient shore, whose dark impressions are presented in beautiful relief on the light grey of the slate, we find the delicate fronds of Sphenopteris *(S. cysteoides)* and Hymenophyllites *(H. macrophylla)*, together with the broad-leaved tribe Tæniopteris, one species of which *(T. vittata)* is identical with the form found in the carbonaceous shale of the Lower Oolite on the Yorkshire coast, in the vicinity of Scarborough. The beautiful Cycadaceæ, of which the Zamia of New Holland gives an existing example, are represented by such forms as Palæozamia *(P. pectinata, P. taxina)*, Zamites *(Z. lanceolatus)*, and Pterophyllum *(P. comptum, P. minus)*. The three last-named species occur likewise in the Scarborough oolite. There is also a singular reed-like leaf, as yet undescribed, about twelve inches in length by one in breadth, destitute of a mid-rib, and with nervures parallel with its edges. The small extreme branches of coniferous plants are among the frequent fossils of the slate. One kind possesses affinities with the yew *(Taxites)*, but most of them are more allied to the cypress, and have received the name of Thuytes *(Thuytes cupressiformis)*, with three other species. Of the fruits of these coniferæ there are several varieties, one kind in shape and size not unlike the berry of the yew, some of its more perfect examples still retaining their outer integument, or husk.

Examples of another species are termed by the quarrymen "plumstones," to which, in truth, they possess a resemblance. There is also a fine Zamioid fruit, with the scales attached to the axis *(Bucklandia squamosa)*, and others that appear referable to large pine-like trees; these at present receive the merely provisional title of Carpolithes. Besides these ferns and coniferous plants, there is likewise a small one, whose delicate yet distinct impressions are apparently very much akin to those of the moss family. Neither the roots nor stems of any of these plants have been found at Stonesfield; from this circumstance, and that of their occuring as detached leaves and twigs, we may reasonably infer that the place of their interment was not the spot on which they grew, but that they were drifted from some shore probably lying at no great distance.

Leaving the vegetable kingdom and ascending to that of the animal, we find in these beds but few zoophytes, these organisms being chiefly confined to the upper division of the Bath Oolite already mentioned. The Annelida are represented by a small serpula, and the crustacea by a small lobster *(Glyphia rostrata)*, and a small species of crab *(Eryon)* not yet named. Faint but unmistakable relics appear of that department of animal life usually regarded as the most frail and perishing, namely the class of insects; nevertheless, the remains of primeval beetles and dragon-flies are preserved in the fossil state. The most frequent specimens of this kind are the elytra, or wing-cases of beetles allied to the Buprestidæ, or Prionidæ, races which abound in warm, but are not excluded from temperate, climates. The Oxford Museum contains the wing of a neuropterous insect allied to the dragon-fly, most elaborately described by Dr. Buckland, and likewise the hind-leg of a species of Curculio, exhibiting the peculiar adaptation for leaping.

Having noticed the insects, the Mollusca, or shell-fish, now claim our attention, and we remark their number to be comparatively limited. The Brachiopoda are represented by two species of Rhynchonella (*R. concinna* and *R. obsoleta*). Among the Monomyarian bivalves may be enumerated three species of Gervillia (*G. acuta*, *G. subcylindrica*, and *G. ovata*), three of Lima (*L. impressa*, *L. duplicata*, and *L. proboscidea*), two of Inoceramus (*I. obliquus* and *I. amygdaloides*), two of Pinna (*P. ampla* and *P. cuneata*), three of Pecten (*P. lens*, *P. annulatus*, and *P. vagans*), one of Perna (*P. rugosa*), and several species of Ostræa, the best defined of which are *O. acuminata* and *O. Sowerbii*. The Dimyarian bivalves also comprise several genera distributed as follows:—Two species of Modiola (*M. plicata* and *M. implicata*), two of Pholadomya (*P. acuticosta* and *P. Murchisonii?*), two of Trigonia (*T. Moretonii* and *T. impressa*), the latter being highly characteristic of this formation, and occurring in great abundance, its opened valves completely covering the surfaces of many of the slates; one of Mytilus (*M. sublævis*), one of Cardium (*C. acutangulum*), also a species of Unicardium and *Mya calceiformis (?)* The Gasteropodous univalves include *Alaria trifida*, *Patella rugosa*, *P. Romeri (?)*, two species of *Natica*, one of *Actæonina*, one of *Turbo*, and a small *Nerita*, which often retains very distinct traces of the black and yellow bands of colour that adorned its shell. The Cephalopoda are represented by but few species, and individually they exhibit an equal paucity of numbers; we may, however, enumerate *Belemnites fusiformis* and *B. Bessinus*, associated with *Nautilus Baberi* and *Ammonites gracilis*, with the cast of another Ammonite, too imperfect for identification.

Still ascending in the scale of animated beings, the fossil fishes of Stonesfield come under our consideration. The greater number of these have been described by Agassiz, and constitute a large and extremely interesting group, although rarely more than fragmentary, and chiefly represented by the teeth, scales, and "spears," as the workmen term the ichthyodorulites, with a true rendering of the

Greek name. These parts are so characteristic, and preserved in such a degree of perfection, as in most cases to admit of correct reference to the families and genera. The species are all extinct, and belong to the Placoid and Ganoid divisions of the four great orders of fishes established by Agassiz. Of these there are but few living examples, as the fishes that inhabit the seas of the existing period belong, with a limited number of exceptions, to the other two orders, Ctenoid and Cycloid, which were not introduced until the Cretaceous epoch, an era when the more ancient Placoids and Ganoids had already begun to decline. The Placoid fishes of the Stonesfield Slate are referable to three families, namely, the Cestraciontidæ, Hybodontidæ, and Edaphontidæ. The Cestraciontidæ are represented by species of the genera *Acrodus*, *Asteracanthus*, *Strophodus*, *Ceratodus*, *Leptacanthus*, *Nemacanthus*, and *Pristacanthus*. The teeth of this family form their chief characteristic, and under the name of Palates have attracted much attention from palæontologists. These palatal teeth are flat and oblong, or quadrangular in shape, and often beautifully enamelled. Beneath the enamel, the surface of which is frequently worn away, the body of each tooth is composed of a strong mass of bone. In some species not less than sixty of these teeth were embedded in each jaw, forming a kind of tesselated pavement, which constituted a most efficient apparatus for crushing the shells of crustacea and mollusca, probably the principal food of these fishes. The *Cestracion Phillipi*, a shark that inhabits the Australian seas, presents the only known analogy to the extinct Acrodi and Strophodi of Stonesfield. The palatal teeth most frequently to be met with in the slate are those of *Acrodus leiodus*, and sometimes measure one and a half inches in length by three-quarters in breadth. These, from their resemblance in form and colour to contracted leeches, they are regarded as such by the workmen, who are seldom without an analogy for any fossil they may offer for sale to the stranger geologists who visit their pits. Indeed, so far is the wisdom of philosophy transcended by that of these unlettered sages, that in cases where the mere scientific observer can only perceive the most ordinary fragments of stone or slate, these village savans can frequently succeed in demonstrating most clearly to their *own* satisfaction the presence of strange creatures that, like man, must have been most fearfully and wonderfully made, if they had ever been possessed of existence. Unfortunately, however, for the theories of these gifted men, all such specimens are invariably declined with thanks by those visitors possessed of the slightest knowledge of palæontology. Many amusing instances of these attempts at restoration might be related; we merely allude to them in order to convince those who are comparatively young geologists, that a certain degree of caution is requisite in their purchases of specimens from the quarrymen.

The Hybodontidæ are represented by various species of Hybodus, chiefly recognized by their striated teeth, which are sharp-edged and well adapted for cutting. Many varieties of these are found at

Stonesfield, the more perfect specimens in some instances retaining the serrated sockets by which they were inserted in the jaw. Fine specimens of the defensive fin-spines (Ichthyodorulites) of these Hybodi are sometimes found. These singular fossils were at one time regarded by naturalists as the jaws of fishes; they are now, however, ascertained to be the defensive weapons of sharks, the supposed teeth that in some species arm their concave sides, being the hooks or prickles to which the membrane of the fins was attached. Several living species of the great family of sharks have smooth horny spines connected with the dorsal fin, and similar small toothless spines occur in a fossil state in the chalk formation. Ten species of the genus Ganodus represent the Edaphodontidæ. The Ganoid fishes of Stonesfield belong to the four families Pycnodontidæ, Lepidoidei, Sauroidei, and Cœlacanthi. The Pycnodontidæ are represented by the genera *Pycnodus*, *Gyrodus*, *Gyronchus*, and *Scaphodus*. The remains of this family most frequently found are the small round palatal teeth of *Pycnodus trigonus*, generally occurring in an insulated condition, but sometimes met with in small groups retaining the position they once occupied in the jaw. The family Lepidoidei has only two genera as its representatives in the formation under review, namely *Lepidotus* and *Pholidophorus*. These are distinguished by their enamelled scales, rhomboidal in form, and in some species smooth and glistening, but in others curiously plicated or folded. Small jaws are also sometimes obtained belonging to *Lepidotus tuberculatus* (?); these retain the teeth in a considerable degree of perfection. The Sauroidei are represented by the genera *Sauropsis*, *Caturus*, *Macrosemius*, and *Belonostomus*. The fishes of this voracious family combine both in the structure of their bones and some of their soft parts characters belonging to the class of reptiles. The Sauroid fishes are distinguished by their beautifully striated teeth, nearly conical, with conical cavities like the teeth of Saurians. In some species the base of the tooth is fluted like that of the Ichthyosaurus. The nearest analogues presented to these fishes in the existing creation are the Lepidosteus, or bony pike of North America, and the Polypterus of the South African coast. Of the Cœlancanthi only a single species, *Ctenolepis clyclus*, is known at Stonesfield.

From the fishes of Stonesfield we ascend to its reptiles, the most famous of which is the *Megalosaurus Bucklandii*. The thigh-bones of this animal measured three feet, and the leg-bones, which were hollow, the same length; and the vertebræ were also of great size. Portions of its jaws, armed with long thin serrated teeth curved in the form of a pruning knife, are preserved in the Oxford Museum. From these remains, Dr. Buckland conjectured this enormous lizard to have been twice the length of a crocodile, or thirty or forty feet.

Associated with the Megalosaurus are found the remains of another saurian of considerably smaller dimensions (*Teleosaurus Cadomensis*), possessing affinities with the recent crocodiles. Those strange flying

reptiles the Pterodactyles are represented by one species (*P. Bucklandi*), chiefly known by its wing-bones, remarkable for their length, and which, like those of birds, were hollow in the middle, thus combining extreme lightness with strength. The family of turtles are known in these beds by one small species of *Chelonia*.

The remarkable catalogue of associated life exhibited by these rocks is rendered still more complete by the occurrence of three genera of Mammalia, namely, *Amphitherium*, *Phascolotherium*, and *Stereognathus*. Of these the only known remains are a few specimens of the lower jaws, with small cuspidated teeth, indicative of a small insectivorous quadruped, probably allied to the opossums, and other marsupial genera now confined to Australia and Tasmania. It is extremely interesting to observe that this resemblance to existing forms of Australian life is by no means limited to the mammalia of the Oolite. For instance, in the Australian sea exists the *Cestracion Phillipi*, or Port Jackson shark, the only known representative of the numerous species of Acrodi and Strophodi, the palatal teeth of which are so abundant in the Oolitic beds. There also living Terebratulæ are found associated with a species of Trigonia, the extinct forms of which are among the most common of the Stonesfield fossils. On the continent of Australia also flourish the Araucariæ and Cycadaceæ, coniferous plants, very nearly allied to the vegetable remains of the Stonesfield Slate.

If we review the fossil treasures of Stonesfield in the aggregate, we can to some extent reproduce that period of the earth's history in which the district under our notice was a lagoon with bordering marshes, intervening between a line of coast on the one hand, and the ancient Oolitic ocean on the other. Every circumstance connected with these finely laminated and ripple-marked sandstones indicates the nature of the process by which they were deposited to have been slow and gradual, doubtless demanding similar conditions to those which would prevail in a shallow sea-lake, penetrated at intervals by moderate swells, or gentle tides from the sea, but not exposed to storms or fluctuations caused by violent littoral action.

We may picture to ourselves the inhabitants of this lagoon, constituting a large population, beautiful branching star-corals analogous to those forming the reefs and islets on which the broad Pacific smiles, aristocratic Nautili and Ammonites associated with their humbler neighbours, the Trigoniæ, Terebratulæ and oysters that furnished a supply of food for the numerous sharks and other predaceous fishes infesting the wide open sea, and frequently visiting this quiet lake in quest of prey. On the ancient land lived that monstrous reptile the Megalosaurus and the crocodile-like Teleosaurus, with a few turtles; strange winged lizards, the Pterodactyles, hovered in the air, or snatched their prey from the calm waters below; and insects like dragon-flies flitted over the reedy marshes. From time to time fragments of bordering plants floated in the shallow pools, either swept down by inundations or driven by the wind;

leaves of ferns, branches, and fruits of coniferous trees like the yew and cypress.

Thus we see that in this lonely and, to the superficial eye, utterly unattractive village, we tread upon a spot once instinct with animal life in its most marvellous organic forms. It is a subterranean museum closely and securely packed, a treasury for palæontologists, a storehouse containing numerous instances of the skill, power, and wonderful resources of creative Omnipotence, which could people a world with the strangest organisms, and yet permit them for so many ages to remain hidden and entombed, being well able to dispense with their testimony to its powers.

THE CARBONIFEROUS SYSTEM IN SCOTLAND CHARACTERIZED BY ITS BRACHIOPODA.

By Thomas Davidson, Esq., F.R.S., F.G.S., Hon. Member of the Geological Society of Glasgow, etc., etc.

(Continued from page 240.)

" This group in Northumberland is seen, westward of Alnwick at Garmitage-bank and Crawley Dean, and on the flanks of the porphyry of the Cheviot in Biddleston Burn, and in the Coquet below Linn Brig; it occupies a considerable area in the south part of Berwickshire, and is largely developed on the Tweed at Carham, Coldstream, Norham, etc.; it is seen underlying the mountain-limestone on the sea-coast from near Lammerton Shiel to Burnmouth; on the north side of Lammermuirs it is intercalated between the Old Red Sandstone, and the mountain-limestone from the Pees mouth to the Cove harbour."

Mr. Tate observes also that the Campsie and Fifeshire beds resemble those of Northumberland.

We will now conclude by offering a list of the Scottish localities, distance, and direction from certain towns, as well as of the nature of the sediments in which Carboniferous Brachiopoda and other marine fossils have been hitherto procured, with the hope that such may prove of use to collectors and geologists generally, and by thanking all those kind and zealous friends for the great interest and important assistance they have afforded me during the prosecution of this somewhat lengthened inquiry.

SCOTTISH COUNTIES IN WHICH THE FOLLOWING CARBONIFEROUS BRACHIOPODA HAVE BEEN DISCOVERED.*

Genera and Species.	Lanarkshire.	Renfrewshire.	Ayrshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peebleshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kirkcudbrightshire.
1. *Terebratula hastata*, Sow...	+	+	+			+			+			+		
2. ——— *sacculus*, Martin .	+		+			+				+				
3. ———*vesicularis*, de Kon										+				
4. *Spirifera duplicicosta*, Phil.	+		+	+		+			+	+		+		
5. ——— *bisulcata*, Sowerby.	+	+	+	+	+	+								+
6. ——— *trigonalis*, Sowerby	+	+	+	+	+	+			+		+	+		
7. ——— *ovalis*, Phillips	+		+			+					+			
8. ——— *pinguis*, Sowerby...	+?													
9. ——— *glabra*, Martin	+	+	+			+								+
10. ——— *Urii*, Fleming	+	+	+			+			+			+		
11. ——— *Carlukiensis*, Dav...	+													
12. ——— *lineata*, Martin......	+	+	+	+	+	+			+			+		+
13. *Spiriferina cristata*, var. *octoplicata*, Sowerby	+	+	+	+		+			+	+		+		
14. ——— *insculpta*, Phillips	+													
15. ——— *laminosa*, M'Coy												+	+	
16. *Athyris ambigua*, Sowerby.	+	+	+	+	+	+					+	+	+	
17. ——— *plano-sulcata*, Phil.	+	+	+			+			+	+		+		
18. ——— *Royssi*, l'Eveillé ...	+	+	+			+			+		+	+		
19. *Retzia radialis*, Phillips ...	+	+												
20. *Rhynchonella pugnus*, Mar.	+	+	+		+	+			+			+		
21. ———*pleurodon*, Phil.	+	+	+		+	+	+		+		+	+	+	
22. *Camarophoria crumena*, Sow										+				
23. *Strophomena rhomboidalis*, var. *analoga* and *distorta* Sowerby	+	+	+			+							+	
24. *Streptorhynchus crenistria*, Phillips, and var. *radialis* and var. *Kellii*...........	+	+	+	+	+	+			+		+	+	+	
25. *Orthis resupinata*, Martin...	+		+	+	+	+		+	+		+	+		+
26. —— *Michelini*, l'Eveillé ...	+	+	+		+	+		+			+	+	+	
27. *Chonetes Hardrensis*, Phil. .	+	+	+	+	+	+					+	+		
28. ——— *Buchiana*, de Kon. .	+													
29. *Productus giganteus*, Martin	+		+	+		+	+	+	+		+	+	+	
30. ——— *latissimus*, J. Sow	+	+	+	+		+								
31. ——— *cora*, d'Orbigny...		+	+		+	+					+			

* This Table shows the Shires in which Carboniferous strata exist, as well as the amount of work done in the way of collecting organic remains. Those counties from which few species are recorded will no doubt upon fuller exploration be found to contain many more of the common species; and a glance at the table will also prove that the shires bordering around Glasgow have been more fully explored than almost any others, and if the other carboniferous fossils had been included in the list, it would have been likewise seen that the Glasgow district is by far the richest fossiliferous portion of Scotland.

SCOTTISH COUNTIES IN WHICH THE FOLLOWING CARBONIFEROUS BRACHIOPODA HAVE BEEN DISCOVERED (*Continued*).

Genera and Species.	Lanarkshire.	Renfrewshire.	Ayrshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peebleshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
32. *Productus semireticulatus*, Martin, and var. *Martini*, Sowerby	+	+	+	+	+	+	+	+	+	+		+	+	+
33. ——— *carbonarius*, de Koninck	+?													
34. ——— *longispinus*, Sow.	+	+	+	⊦	+	+			+		+	+	+	
35. ——— *undatus*, Defrance	+				+	+								
36. ——— *costatus*, Sowerby	+	+	+	+	+	+								
37. ——— *Youngianus*, Dav.	+	+	+			+						+		
38. ——— *scabriculus*, Mar.	+	+	+		+	+					+	+	+	+
39. ——— *pustulosus*, Phil.					+						+			
40. ——— *fimbriatus*, Sow...	+		+			+					+	+		
41. ——— *punctatus*, Martin	+	+	+	+	+	+					+	+		
42. ——— *aculeatus*, Martin	+	+	+			+					+			
43. ——— *spinulosus*, Sow...	+		+							+	+			
44. ——— *mesolobus*, Phil.	+					+								
45. *Crania quadrata*, M'Coy ...	+	+	+			+								+
46. *Discina nitida*, Phillips ...	+	+	+			+			+		+	+	+	
47. *Lingula squamiformis*, Phil.	+			+	+	+			+		+		+	
48. ——— *Scotica*, Davidson...	+													
49. ——— *mytiloides*, Sowerby	+	+	+			+			+			+	+	

LIST OF LOCALITIES IN SCOTLAND WHERE CARBONIFEROUS BRACHIOPODA HAVE BEEN FOUND.

Lanarkshire.

	Distance and Direction from Carluke Kirk.	*Stratigraphic position below Ell coal.*	*Nature of Strata.*
Belston Place Burn	$1\frac{1}{4}$ miles N.	160 fathoms.	Slaty ironstone.
Belston Place Burn	$1\frac{1}{4}$ m. N.	173 "	Ironstone shales.
Gare Limestone	2 m. N.E.	239 "	Old shale heaps.
Westerhouse	3 m. E.N.E.		Old shale heaps.
Bashaw	$1\frac{1}{2}$ m. N.E.		Old shale heaps.
Whiteshaw	$\frac{1}{4}$ m. W.		Old shale heaps.
Belston Burn Limestone......	$\frac{1}{2}$ m. N.E.	265 "	Limestone and shales.
Maggy Ironstones	—	300 "	
Brocks Hole	1 m. E.		Ironstones and shales.
Below Whiteshawbridge...	1 m. W.		Ironstones and shales.
Near Chapel	2 m. S.		Ironstones and shales.
Lingula Ironstone	—	317 "	
Braidwood Gill...............	2 m. S.		Ironstone and shale.

	Distance and Direction from Carluke Kirk.	*Stratigraphic position below Ell coal.*	*Nature of Strata.*
Lingula Limestone	2 m. S.	337 fathoms.	
Hallcraig Bridge	1½ m. W.		Limestone and shales.
Raes	2 m. W.		
Langshaw Burn	1 m. S.E.		
Braidwood Burn	2 m. S.		
1st Kingshaw Limestone	—	338 „	
Hallcraig Bridge	1½ m. W.		Limestone and shales.
Kingshaw	1 m. N·E.		
2nd Kingshaw Limestone	—	341 „	
Hallcraig Bridge	1½. m. W.		Limestone and shales.
Langshaw	1 m. S.E.		
Kingshaw	1 m. N.E.		
1st Calmy Limestone	—	343 „	
Raes Gill	2 m. W.		Limestone and shales.
Braidwood	1½ m. S.		
Langshaw	1 m. S. E.		
Waygateshaw	1 m. S.		
Headsmuir	1¼ m. S.E.		
Raes Gill Ironstones	—	354 „	
Raes Gill	2 m. W.		Alternate beds of ironstone and shale.
Waygateshaw	1 m. S.		
Braidwood	1½ m. S.		
Langshaw	1 m. S.E.		
Kilcadzow	3 m. E.		
Hillhead	1 m. E.		
Hosie's Limestone	—	356 „	
Hillhead	1 m. E.		Limestone and shale.
Raes Gill	2 m. W.		
Waygateshaw	1 m. S.		
Braidwood	1½ m. S.		
Mosside	1 m. N.E.		
2nd Calmy Limestone	—	371 „	
Braidwood	1½ m. S.		Limestone and shales.
Mosside	1 m. N.E.		
Kilcadzow	3 m. E.		
Main Limestone	—	375 „	
Braidwood	1½ m .S.		Limestone and shales.
Langshaw	1 m. S.E.		
Mosside	1 m. N.E.		
Bashaw	1½ m. N.E.		
Kilcadzow	3 m. E.		
Shelly Limestone	—	391 „	
Braidwood Gill	2 m. S.		Limestone.
Nellfield Burn	2 m. S.E.		
Productus Limestone	—	397 „	
Braidwood Gill	2 m. S.		Limestone and shales.
Nellfield Burn	2 m. S.E.		
Near Yuildshields	2 m. E.		
Ironstone Beds	—	410 „	
Nellfield Burn	2 m. S.E.		Ironstone and shales.

The foregoing list embraces strata in descending order where Brachiopoda and other fossils have been found in Carluke parish, and for which I am indebted to a local inquirer, whose knowledge of the district and its localities has extended over thirty years' duration.

Brockley	6	miles	S. of Lesmahago	Limestone and shale.
Coalburn	4	,,	S. ,,	,,
Brown Hill	2	,,	S. ,,	,,
Middleholm	2	,,	S.W. ,,	,,
Moat	3	,,	E. ,,	,,
Coalburn	4	,,	S. ,,	Ironstone and shale.
Hall Hill	3½	,,	N.E. ,,	,,
Auchenbeg	3	,,	S. ,,	Limestone and shale.
Kersegill	1½	,,	N. ,,	,,
Birkwood	2	,,	N. ,,	,,
Dykehead	3	,,	N.W. ,,	,,
Auchenheath	3	,,	N. ,,	Ironstone and shale.
Den	3	,,	N. ,,	Limestone and shale.
Dalgow	3	,,	W. ,,	,,
Flat	5	,,	N.E. ,,	,,
Crossford	2	,,	S. of Braidwood	,,
Gallowhill	¾	,,	E. of Strathavon	,,
Limekiln Burn, Boghead	3½	,,	S.W. of Hamilton	Limestone.
Auchentibber	1½	,,	S.W. of High Blantyre	Limestone and shale.
Calderside mines	2	,,	S.W. of ditto	,,
Brankamhall, Calderwood	1¼	,,	S. of East Kilbride	,,
Capelrig, Calderwood	1	,,	E. ,,	,,
Limekilns, near East Kilbride				,,
Lickprivick	2	,,	S.W. ,,	,,
Hermyres	2	,,	W. ,,	,,
Thorntonhall	2½	,,	W. ,,	,,
*Parliamentary-road, corner of North Frederick-street, Glasgow				Calcareous sandstone and shale.
Robroyston	2	,,	N.E. of Glasgow	Old shale heaps.
Bedlay, Chryston, Garnkirk, Moodiesburn	6 to 7	,,	,, ,,	Limestone and shale.

Shale above limestone at Bishopbriggs, three miles north of Glasgow.

The Lanarkshire localities, excepting those from the parish of Carluke, have been carefully explored by Mr. J. Armstrong, Mr. J. Thomson, Dr. Slimon, Mr. J. Young, and Mr. Bennie, and comprise likewise those quoted by David Ure, in his "History of East Kilbride."

Stirlingshire.

Calmy limestone and shales; Balquarhage, two miles south-south-east of Lennoxtown.

Corrieburn beds on Campsie Hills, four miles north-east of Kirkintilloch: limestone, ironstone and shales.

* During some building operations in 1857, strata of calcareous sandstone and shale were exposed and quarried; and from the sandstone numerous casts of Productus, Spirifera, &c., were obtained. The rock was built over, but as there is vacant ground to the east and west, it is likely it may be again exposed, and local geologists would do well to profit by such exposure. We may here likewise mention that the whereabouts of David Ure's locality, Darnley, could not be discovered.

Dark grey limestone and shale, twenty-two fathoms above Campsie main limestone; South Hill pits, and Barraston, near Lennoxtown.

Shales above Campsie main limestone, Schiliengow; near Lennoxtown.

Campsie main limestone; Schiliengow, Ferrot's and Gloratt quarries on North Hill, and Alum Work mines and Craigend Muir, South Hill, all near Lennoxtown.

Shelly limestone, ironstone and shale; Balgrochan Burn, half a-mile north of Lennoxtown.

Limestone, ironstone, and shale; Mill Burn, near Lennoxtown.

Ironstone and shale; Balglass Burn, near Lennoxtown.

Limestone, ironstone, and shales; Craigenglen and Glenwine, two miles south-west of Lennoxtown.

In the foregoing list are enumerated all the localities from which Brachiopoda have been obtained in the Campsie district.

Banton	2 miles E. of Kilsyth	Limestone.
Murrays-hall....................	S.W. of Stirling	„

All the Stirlingshire localities have been minutely examined by Mr. J. Young.

Dumbartonshire.

Castlecary........................	near Cumbernauld	Limestone and shale.
Netherwood	ditto 16 miles N.E. of Glas.	„
Duntocher........................	New Kilpatrick, 9½ miles N.W. of Glas.	Bed of limestone and shale, near sandstone quarry.

For these localities I am indebted to Mr. J. Young.

Renfrewshire.

Howood...........................	4 miles W. of Paisley	Limestone and shale.
Wauk Mill Glen, Barrhead ...	Barrhead	
Hurlet	7½ miles S.W. of Glasgow	„
Orchard...........................	1 „ E. of Thornliebank	„
Davieland Quarry	near Thornliebank	„
Arden Quarry	ditto	„
Floors Quarry	near Johnstone	

These, as well as the Ayrshire localities, have been carefully searched by Mr. J. Thomson and Mr. J. Armstrong.

Ayrshire.

West Broadstone	1 mile S. of Beith	Limestone and shale.
Roughwood	near Beith	„
Treehorn	„	„
Auchenskeigh	2 miles S. of Dalry	„
Highfield Quarry	1 „ N.E. „	„
Linn Spout	near Dalry	„
Goldcraig	1 mile E. of Kilwinning	„
Monkredding	1½ „ E. of ditto	„
Hallerhirst	near Stevenston	„
Craigie	near Kilmarnock	„
Cessnock	1 mile S.E. of Galston	„
Alton...............................	2 „ N. „	„
Moscow...........................	3 „ N. „	
Nethernewton	3 „ N.E. „	

Hyndberry Bank	2 miles N.E. of Galston	Limestone and shale.
Meadowfoot	5 ,, E. of Darvel, near Drumclog	,,
Gainford	2½ ,, E. of Stewarton	,,
Bruntland	1 ,, E. of Fenwick	,,
Mulloch Hill	New Dailly	,,

EDINBURGHSHIRE.

Gilmerton, near Edinburgh.
Wardie, ,,
Driden, 6 miles S. of Edinburgh.
Carlops, 14 miles S. ,,
Joppa, near Portobello.
Roman Camp, near Dalkeith.
Cousland ,,
Magazine, 6 miles S.E. of Dalkeith.
Esperston, 2 miles S.E. of Temple.
Crichton Dean, Crichton Castle.
Penicuick.
Cornton, near Penicuick.
Mount Lothian, 3 miles S.E. of Penicuick
Leven Seat, Addiewell, Scola Burn, Baad's Mill — S.W. of West Calder.

PEEBLESHIRE (*North part adjoining Edinburghshire.*)

Bents.
Lamancha.
Whim.
Whitfield.

HADDINGTONSHIRE.

Prestonpans.
Aberlady.
Longniddry.
Jerusalem.
Salton.
Kidlaw.
The Vaults, E. of Dunbar.
Skateraw ,,
Cat Craig ,,
East Barns, near Dunbar.
Saughton, 4 miles W. of Haddington.

LINLITHGOWSHIRE.

Kinniel, Dykeneuk, Craigenbuck — W. of Borrowstownness.
Tod's Mill, River Avon.
Caribber, S.W. of Linlithgow.
Bowden Hill, S.W. ,,
Bathgate Hills.
Balbardie, near Bathgate.
Blackburn, S.E. ,,
Breichwater, above Breichdyke.

LINLITHGOW (*Continued*).

Hillhouse, 1 mile S. of Linlithgow.
Tartraven, 3 ,, S.E. ,,

FIFESHIRE.

Ladedda, Wilkieston, Winthank — 3 miles S.W. of St. Andrews.
Craig Hartle, near St. Andrews.
Craighall, Cult's Hill, Forthar — 3 miles S.W. of Cupar.
St. Monance, 3 miles W. of Anstruther.
Strathkenny, St. Andrews.
Dumbarnie, near Largo.
Chapel, Bogie, Inverteil, Seafield — near Kirkcaldy.
Sunnybank, N. of Inverkeithing.
Parkend, N.E. ,,
Brucefield, S.E. of Dunfermline.
Rescobie, N. ,,
Duloch, E. ,,
Charlestown.
Rosyth, west of the Castle.
Crombie Point.
Bucklyre, N. of Aberdour.

BERWICKSHIRE.

Cove at Cockburnspath.
Marshall Meadows, 3 miles N. of Berwick.
Coast between Lammerton and Berwick.

DUMFRIESSHIRE.

Closeburn.
Hollows, 4 miles S. of Langholm.

KIRCUDBRIGHTSHIRE.

Coast at Arbigland, parish of Kirkbean.

This locality has been explored by Mr. John Steven, of Glasgow.

BUTESHIRE.

Ascog, in Bute.
Corrie, Arran.
Salt Pans ,,

For much of the information relative to the localities in the last nine counties I am indebted to Mr. Geikie, Mr. Page, Mr. Tate, Prof. Ramsay, Mr. Fraser, the late Dr. Fleming, and H. Miller; as well as to Sir R. Murchison and Mr. Salter, who have kindly allowed me access to the lists and specimens assembled during the Geological Survey of Scotland. I wish likewise to express my thanks to Profs. de Koninck and Phillips, Mr. Hancock, and to Dr. Gratiolet, of Paris, for some of the information I have been able to communicate; and to Mr. Mackie for the care and trouble he has bestowed upon the publication of this memoir.

EXPLANATION OF THE PLATES.

Plate XII. in Vol. II. of the "Geologist."

Fig. 1. *Terebratula hastata*, Sow. Nellfield, Lanarkshire.

2. ——— ———. From Ayrshire; in the collection of Mr. Young. This specimen shows remains of colour marking.

3—4. ——— *sacculus*, Martin. From West Lothian and collection of Dr. Fleming.

5. ——— *vesicularis*, de Koninck. From West Lothian and collection of Dr. Fleming.

6. *Athyris ambigua*, Sow. Hallerhirst, Ayrshire. Collection of Mr. Armstrong.

7. ——— ———. From Carluke, Lanarkshire.

8. ——— ———. Interior of the Ventral Valve. A, adductor or occlusor; R, divaricator muscular impressions; T, teeth; D, dental, or rostral plates.

9. ——— ———. Interior of the Dorsal Valve. A A, quadruple impressions of the occlusor muscle; M, dental sockets; N, hinge-plate; O, point from which the spirals (here omitted) were developed. 8 and 9 are from Capel Rig, East Kilbride, and collection of Mr. Armstrong.

10—11. ——— *plano-sulcata*, Phillips. From Lanarkshire. In fig. 10 a portion of the lamelliform expansions are represented.

12. ——— *Royssii*, L'Eveillé. From Coalburn, near Lesmahago. A portion only of the pectinated fringes are represented.

13. *Retzia radialis*, Phillips, var. From Brockley, near Lesmahago. Since this specimen was figured, several others have been found in the same locality, as well as at Gare.

14. *Spirifera duplicicosta*, Phillips. From Balgrochan Glen, Campsie, Stirlingshire.

15. ——— ———. From West Broadstone, Beith; collection of Mr. J. Thompson.

16. ——— *trigonalis*, Martin. Brockley, near Lesmahago; collection of Dr. Slimon.

17. ——— ———. From Cousland Burn, near Dalkeith.

18. ——— ———. Campsie; collection of Mr. Young.

19. ——— *bisulcata*, Sow. Craigenglen, Campsie; collection of Mr. Young.

20. ——— ———. West Broadstone, Beith; collection of Mr. J. Thomson.

21. ——— ———. Ventral Valve, showing the imbricated surface; from Barrhead; collection of Mr. A. Cowan.

22. ——— ———. West Broadstone; collection of Mr. Armstrong.

23. ——— ———. A coarse-ribbed variety; in the Museum of Practical Geology.

Fig. 24. *Spirifera bisulcata*. Interior of the Ventral Valve; (the letters refer in these figures to the same parts as in figs. 8 and 9.

25. ——— ———. Interior of Dorsal Valve. 24 and 25 are from Capel Rig, East Kilbride.

26. ——— *ovalis*, Phillips. From Corrie Burn; collection of Mr. J. Young. The beak has been restored from another specimen.

27. ——— ———. From West Broadstone. These two figures represent the original type of Dr. Fleming's *Sp. exarata*.

28. ——— *pinguis*, Sow. From near Glasgow (?); in the Museum of Practical Geology. The exact locality is not preserved, but it is certainly a Scottish specimen.

29. ——— *Carlukiensis*, Dav. Hill Head, Lanarkshire. Fig. 29, *a* and *d*, are enlarged.

30. ——— *Urii*, Fleming. Hill Head, Lanarkshire. The lower figures are enlarged, and 30*c* shows the spiny investment considerably magnified.

31. ——— *lineata*, Martin. From West Broadstone, near Beith; fig. 31*b* is enlarged, and shows a portion of the spiny surface, which is still more magnified in 31*c*.

32. ——— *glabra*, Martin. From East Kilbride, collection of Mr. Armstrong.

33. ——— ———. From Middleholm, near Lesmahago.

34. ——— ———. From Orchard-quarry, collection of Mr. Bennie.

35. *Spiriferina insculpta*, Phillips. A fragment from Gare, Carluke parish, 35*a* and *b* are enlarged restored representatives. Better Scottish examples have been recently found.

36. ——— *cristata*, var. *octoplicata*, Sow. From West Lothian. Collection of Dr. Fleming.

37. ——— ———. Lanarkshire.

38. ——— ———. From West Broadstone, Beith; collection of Mr. Thompson.

Plate I., Vol. III.

1. *Rhynchonella pugnus*, Martin. From the Campsie main limestone. Collection of Mr. Young.
2. ——— ———. From Hyndberry Bank, parish of Loudon. Collection of Mr. Thompson.
3. ——— *pleurodon*, Phillips. Corrie Burn; collection of Mr. Young.
4. ——— ———. West Lothian; collection of Dr. Fleming.
5. ——— ———. Capel Rig; collection of Mr. Armstrong.
6. *Camarophoria crumena*, Martin sp. From West Lothian; collection of Dr. Fleming.
7. *Orthis Michelini*, L'Eveillé. From Campsie.
8. ——— ———. Enlarged fragment of the striated external surface, showing the position of the spines, M, and the exterior orifices of the tubular perforations which traverse the thickness of the shell.
9. ——— ———. Interior of the ventral valve, enlarged; A, occlusor; R, divaricator, and perhaps ventral adjustor muscular impressions; N, pedicle scar (?); T, teeth.
10. ——— ———. Interior of the dorsal valve; J, cardinal process; S, dental sockets; L, oral processes (?); A A, occlusor impressions.
11. ——— *resupinata*, Martin. From Robroyston; collection of Mr. Young. Much larger examples are found in Ayrshire.
12. ——— ———. Enlarged fragment of the striated, spinose, and punctured surface.
13. ——— ———. Interior of the ventral valve.
14. ——— ———. Interior of the dorsal valve.

15. *Orthis resupinata*. Variety (?) from Corrie Burn; collection of Mr. Young.
16. *Streptorhynchus crenistria*, Phillips. From Corrie Burn.
17. ——— ———. Outline of a large specimens from West Broadstone. Many examples of Phillips' var. *senilis* have been recently found in the limestone of Boertrapping, three miles south of Glasgow, by Mr. J. Thomson.
18. ——— ———. Interior of the ventral valve.
19. ——— ———. Interior of the dorsal valve.
20. ——— ———. A young specimen from Gare.
21. ——— ———. Longitudinal section to show the space left for the animal between the valves.
22. ——— ———. A small specimen from Gare.
23. ——— ———, var. *Kellii*, M'Coy. From Ayrshire.
24. ——— ———, var. *radialis*, Phillips. From Middleholm; collection of Dr. Slimon.
25. ——— ———. From Gare.
26. *Strophomena rhomboidalis*, var. *analoga*, Phillips. Corrie Burn; collection of Mr. Young.
27. ——— ———. Interior of ventral valve.
28. ——— ———. Interior of ventral valve. A, occlusor; R, divaricator; P, pedicle (?); F, interior opening of foramen, which is closed at X in fig. 27.
29. ——— ———. Interior of the dorsal valve. V, vascular impressions.
30. ——— ———. A very young example, in which both valves are straight.
31. ——— ———. A fragment of the ventral valve, showing the external orifice of the foramen.
32—33. ——— ———, var. *distorta*, J. de C. Sowerby. From Gare.

Plate II.

Fig. 1. *Chonetes Buchiana*, de Koninck. From Gare; 1*a b*, enlarged representations.
2. ——— *Hardrensis*, Phillips. Nat. size. From East Barns, near Dunbar.
3. ——— ———. Interior of ventral valve. A, occlusor; R, divaricator; collection of Mr. Armstrong.
4. ——— ———. Interior of dorsal valve. A A, quadruple impressions of the occlusor; X, reniform impressions. Capel Rig, East Kilbride.
5. ——— ———. A young shell, from Craigie, near Kilmarnock; collection of Mr. Thomson.
6. ——— ———. A young shell from Mill Burn; collection of Mr. Young.
7. ——— ———. A small variety (?) from South Hill, Campsie; collection of Mr. Young.
8. *Productus latissimus*, Sowerby. From near Dalry.
9. ——— ———. Interior of the dorsal valve, from Belston Burn. (A fig. of the ventral valve will be found, pl. iv., fig. 26).
10. ——— *longispinus*, Sow. With its spines restored; from Lanarkshire.
11. ——— ———. From Craigie, near Kilmarnock; collection of Mr. J. Thomson.
12. ——— ———. From the original specimen of *P. longispinus*, Sow. West Lothian and collection of Dr. Fleming.
13. ——— ———, var. *lobatus*, Sow. From Lanarkshire.

Fig. 14. *Productus longispinus.* From the original specimen of Sowerby's *P. Flemingii*; West Lothian and collection of Dr. Fleming.
15. ——— ———. Interior of the ventral valve; from Capel Rig and collection of Mr. Armstrong.
16. ——— ———. Dorsal valve, from the same locality.
17. ——— ———. From the Campsie main limestone; collection of Mr. Young.
18. ——— ———. A curious variety from Gare.
19. ——— ———. A variety in which the sinus has not been developed; *Prod. spinosus*, Sow., from the original example, slightly restored, and collection of Dr. Fleming.
20. ——— *aculeatus*, Martin. From the Campsie main limestone.
21. ——— *mesolobus*, Phillips. From the Glarat lime-works, Campsie; collection of Mr. Young. The shell has also been recently found at Brockley, near Lesmahago, by Mr. J. Thomson.
22. ——— *costatus*, Sow. From Barrhead; collection of Mr. Young.
23. ——— ———, Sow. From near Lesmahago; collection of Dr. Slimon.
24. ——— ———, Sow. Dorsal valve, Barrhead. The interior of the dorsal valve has been recently found at Brockley, by Mr. Thomson.
25. ——— ?. Undetermined species. From Corrie Burn; collection of Mr. Young.
26. ——— *Youngianus*, Dav., type. The usual condition of the species, from the same locality and collection; in pl. v., fig. 7 shows the concentric lines of growth.
27. ——— *fimbriatus*, Sow. From Lanarkshire.

Plate IV.

1. *Productus semireticulatus*, Martin. From Castlecary; collection of Mr. Thomson.
2. ——— ———. Nellfield, Lanarkshire.
3. ——— ———. Interior of the ventral valve. From Calderside; collection of Mr. Armstrong.
4. ——— ———. Interior of the dorsal valve. From Calderside; collection of Mr. Armstrong. A, occlusor; B, divaricators; J, cardinal process. Fig. 4*a*, cardinal process seen from its upper surface. Fig. 4*b*, a smaller portion of the internal surface close to the margin, showing the spinose asperities, M, which covers its surface, as well as the orifices of the minute canals which traverse the shell, N.
5. ——— ———, *P. Scotica*, Sow. From the original specimen in the collection of Dr. Fleming. Figs. 7 and 8 show the disposition of some of the ribs.
6. ——— ———, var. *sulcatus*, Sow. From Carluke parish.
10. ——— ———, var. *Martini*. From ironstone under the Campsie main limestone; collection of Mr. Somerville. Fig. 10*b* shows how the ribs bifurcate upon the lateral portions of the valves.
11. ——— ———. From the same locality.
12. ——— ———, var. *P. concinnus*. From the same locality; and showing how the shell becomes sometimes fractured.
13. ——— *cora*, d'Orbigny. From the Campsie main limestone (Balgrochan Glen beds). A more correctly enlarged fragment of the shell surface will be seen in pl. v., fig. 5.
14. ——— *carbonarius*, de Koninck. In the collection of the Geological Survey this specimen is labelled "North of Glasgow" (?), a very vague indication; and it is possible that the specimen may be from some other district of the Scottish Carboniferous series.
15. ——— *undatus*, Defrance. From the Campsie main limestone.

Fig. 16—17. *Productus undatus.* Two examples, from the same locality and collection of Mr. Young.

18. ——— *scabriculus*, Martin. From the Campsie main limestone. The interior of the dorsal valve will be found represented in pl. v.

19. ——— *pustulosus*, Phillips. North of Glasgow (?); collection of the Geological Survey. The same thing may be repeated here that we have said under fig. 14.

20. ——— *punctatus*, Martin. From near Lesmahago. One part shows the spiny investment, of which 20*c* and *d* are enlarged illustrations.

21. ——— ———. Internal cast of the ventral valve seen from the beak, and showing the relative position of the occlusor (A) to the divaricator (R) muscular impressions.

22. ——— ———. Interior of the dorsal valve; collection of Mr. Armstrong.

23. ——— *spinulosus*, Sow. From the original example in the collection of Dr. Fleming.

24. ——— ———. From near Lesmahago; collection of Dr. Slimon.

25. ——— *costatus*, var. *muricatus*, Phillips. From Cessnock, near Galston. This specimen agrees exactly with the original example so named in the museum of York, and which has been considered a synonym of *P. costatus.*

26. ——— *latissimus*, J. Sow. Interior of the ventral valve. From West Broadstone, Beith; in the collection of Mr. Armstrong.

Plate V.

1. *Productus giganteus*, Martin. Braidwood Gill, Lanarkshire. This species attains more than twice the dimensions of the figure.

2. ——— ———. Interior of the ventral valve. A, occlusor; R, divaricator impressions; L, hollows occupied by the oral arms.

3. ——— ———. Interior of the dorsal valve. A, occlusor; J, cardinal process; X, reniform impressions; Z, prominences corresponding with the hollows (L) in the opposite valve.

4. ——— ———. Hinge-line showing the upper surface of the cardinal process, J.

5. ——— *cora.* A portion of the external surface magnified to show its peculiarly sculptured striæ. Corrie Burn; collection of Mr. Young.

6. ——— *scabriculus.* Interior of the dorsal valve, from two Lanarkshire specimens: the partially divided mesial ridge and cardinal process are peculiar. From the collections of Mr. J. Armstrong and that of another friend.

7. ——— *Youngianus*, Dav. This figure shows the concentric lines of growth, which had not been sufficiently expressed upon the figures already given.

8. *Spiriferina laminosa*, M'Coy. From Lammerton; in the collection of Mr. G. Tate. This is only a cast, the shell being destroyed.

9. ——— ———. A fragment of the shell magnified to show the disposition of the laminæ which adorn the surface.

10. *Spirifera bisulcata.* A remarkably elongated variety, in the Hunterian Museum, Glasgow College. A similar specimen has been found near Lesmahago.

11. ——— *trigonalis* (?). Campsie; formerly in the collection of Mr. A. Cowan, now in that of the Geological Society of Glasgow. I am somewhat uncertain whether this shell, of which many similar examples have been found, is in reality a variety of *Sp. trigonalis* or of *Sp. duplicicosta.*

12—13—14. *Crania quadrata*, M'Coy. From Capel Rig and Calderside; in the collection of Messrs. Thomson and J. Armstrong.

Fig. 15—16. *Crania quadrata*. From Gare, in Lanarkshire.

17. ——— ———. A remarkable fragment of encrinal stem, upon which no less than from twelve to thirteen specimens of the Crania had clustered. Capel Rig, East Kilbride.

18—20. ——— ———. Three specimens, showing the exterior of the larger or free valve, from Capel Rig; in the collection of Messrs. Armstrong and Thomson.

21. ——— ———. A specimen of *Discina nitida*, upon which four Cranias had congregated.

22—27. *Discina nitida*, Phillips. Exterior of the larger or free valve, from Capel Rig and Raes Gill; principally from the collection of Mr. Armstrong.

28. ——— ——. Exterior of the smaller or perforated valve. From Auchentibber, High Blantyre; collection of Mr. Bennie.

29. ——— ——. From Raes Gill.

30. *Lingula squamiformis*, Phillips. Nat. size. From Corrie Burn; collection of Mr. Young.

31. ——— ———. Another example, in the Museum of Practical Geology.

32. ——— ———. Interior of the ventral valve, and an internal cast of the dorsal one; from 341 fathoms below "Ell Coal," in the parish of Carluke. A, occlusor impression.

33. ——— ———. A beautifully perfect example of the dorsal valve, showing the three ridges often observable in this species. From the parish of Carluke.

34. ——— ———. From Haw Hill, near Lesmahago; collection of Dr. Slimon.

35. ——— ———. Interior surface and usual dimensions of the specimens found in Carluke parish.

36. ——— *Scotica*, Dav. From Hall Hill, Lesmahago; collection of Dr. Slimon.

37. ——— ———. Gare; collection of Mr. Young.

38. ——— *mytiloides*, Sow. A typical example, from Craigenglen, Campsie; collection of Mr. Young.

39—41. ——— ———. Varieties = *L. elliptica* and *L. parallela*, Phillips. From Orchard-quarry, Capel Rig and Robroyston; collections of Messrs. Bennie and Thomson.

42. ——— ———. A very elongated variety, from Marshall Meadows, Berwickshire; in the collection of Mr. G. Tate.

43. ——— ———. This specimen was found highest in the formation, viz., at 160 fathoms below "Ell coal," and 13 fathoms above the Discina bed in the parish of Carluke.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geologists' Association.—The Annual Report of the Association has recently been printed, and gives a most satisfactory account of the prospects and advance of this Society. During the present year the following papers have been read* :—

"On the Theory of a Gradual Withdrawal of Heat from the Earth as Explanatory of certain Geological Phenomena." By J. Curry, Esq.

* The Proceedings of this Society are published at the "Geologist" Office, price One Shilling each.

"On the Geology of Whitecliff Bay, in the Isle of Wight." By Mr. Mark Norman.

"On a Stalactite found in Flagstone-rock at Haslingden, near Manchester." By the Rev. L. H. Mordacque.

"On the Crag." By E. Charlesworth, Esq., F.G.S.

"On the Action of Heat on certain Sandstones of Yorkshire." By C. Tomlinson, Esq.

"On Flint Implements from the Drift." By S. J. Mackie, F.G.S., F.S.A.

The Committee of the Association having come to the very desirable resolution of having occasional excursions to places of geological interest, the first excursion was made on Monday the 9th of April, when a number of members, under the guidance of the Rev. Thos. Wiltshire (the President) and Prof. Tennant, visited Folkestone, and spent several hours in the Warren, in East Wear Bay, and at Copt Point, examining the formations and procuring the characteristic fossils of the Gault. Another excursion to Maidstone took place on the 19th ult., when a large party visited the "Iguanodon" quarries worked by Mr. Bensted; the "Charles" Museum, in which is placed Mr. Bensted's unique collection of Siphoniæ (?) from the Kentish rag-beds of his quarry; and the river-drift beds at Aylesford.

As the Association have, with most praiseworthy liberality, thrown these excursions open to any friends of the members, we recommend them to the notice of of those our readers who desire field-instruction in geology, in the assurance that they will not fail to find them useful and agreeable holidays.

We are gratified to find that the suggestions made in this journal have been so energetically taken up by this Society, and in that liberal and non-exclusive manner which is so fully in accordance with our own views and wishes. We regret that an accident at press with our last number compelled us to substitute other matter for the notice we intended giving of the then proposed excursion to Maidstone. We hear that a third excursion to Dulwich will be proposed for July.

NOTES AND QUERIES.

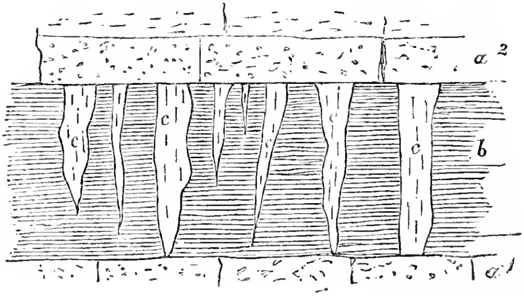
Chemical Evidence of the Spongeous Nature of Flint Fossils.—If a flint coated with chalk be immersed in hydrochloric acid, the chalk will be dissolved and the flint will remain unaffected. In many instances, however, there is a point beyond which the acid, even if renewed, will not act, and a white coating is left which neither nitric, sulphuric, nor hydrochloric acid will touch. This incrustation I have found to consist of sulphate of lime. It is met with on those flints which contain fossils, such as sponges, &c. I have several specimens of laminated flint presenting this peculiarity. I have also a fossil echinus from which the chalk has been entirely removed by acid, and on which the sulphate remains beautifully arranged only around the lines of orifices between the plates.

May I presume to draw the inference that the above facts lend confirmation to Dr. Bowerbank's views on the spongeous basis of many flints? May they not also be adduced in support of the opinion that holds the animal nature of sponges? We know that animal substances are partly albuminous, and that sulphur is one of the elements of albumen. The animal substance, in undergoing decomposition, during or previous to fossilization, would part with its sulphur, which would be seized by the lime of the chalk in immediate contact

with it, and hence the coating of sulphate of lime, for which I was totally unable to account, until Dr. Bowerbank was kind enough to impart to me some of the vast information he has amassed on the nature and habits of sponges, recent and fossil.—W. B. KESTEVAN, Upper Holloway.

ON THE VERTICAL VEINS OF DARK LIMESTONE IN RED SHALE AT TEMPLEMORE.—DEAR SIR,—Permit me to offer an explanation for the occurrence of those "irregular vertical veins or thin dykes of dark grey compost limestone, which cross a nearly horizontal bed of red shale near the base of the old red sandstone of the neighbourhood of Templemore," to which attention has been directed by your correspondent A. B. W., in the April number of "THE GEOLOGIST."

Let us suppose that the accompanying diagram, fig. 1, represents the face of this bed.



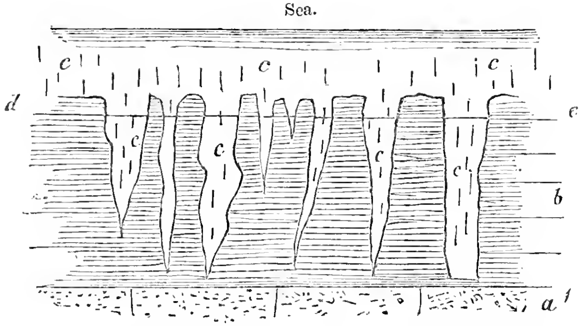
Lign. 1.—*a*, Sandstone; *b*, Shale; *c c*, Limestone mud filling up fissures; *d e*, Limit of denudation.

After the deposition of the shale *b*, and while it was yet in the state of mud, the sea bottom at this place became suddenly elevated above the waters, and subjected to rapid dessication, which produced numerous cracks and fissures over its surface; and these after a time were doubtless increased in dimensions by subsequent atmospheric action. The land was then submerged; but during the interval of this upheaval and dessication, the sea around this particular area had ceased to deposit ferrugio-argillaceous mud as well as sand, owing, doubtless, to local changes of currents, the result possibly of those movements in the land which I have just supposed. Its sediment now consisted entirely of such highly calcareous materials as would be capable of forming limestone only, and this, of course, filled up these cracks and fissures, and any other irregularities which existed over what was then the bottom of the sea.

It is remarkable that in the neighbourhood of Templemore absolute beds of pure dark grey limestone are frequently found interstratified with the old red sandstones, and we may therefore rationally suppose that the shale which I am describing may have been at one time covered by a bed of such limestone as I have alluded to, at which period of its history the section at this locality may have been that which I have represented in the diagram fig. 2.

After a time, the calcareous mud not only ceased to be deposited here, but another great and material change took place in the relative distribution of land and water. The sea bottom became sufficiently elevated to be brought

under the errosive action of the breakers, whereby not only all the bed of limestone mud was removed, but a small portion from the top of the argillaceous shale bed also, as far down, we may suppose, as the line *d—e* (fig. 2). This accomplished, the shore was once again depressed deep beneath the sea, and thus protected from further destruction.



Lign. 2.—*a a*, Sandstone; *b*, Red shale; *c*, Fissures filled with limestone.

This last great physical change appears to have brought back the normal conditions under which the ferruginous and non-calcareous materials forming the mass of the Old Red Sandstone were deposited, and thus the shale with its limestone-filled fissures, was covered by the ordinary sandstones of its type of rock. The formation of the Old Red Sandstone then went on uninterruptedly till its time was accomplished, and the "carboniferous sea" was spread over all that extensive area, of which the central-western and south-western portion of Ireland now forms but a very small part.—Yours truly, GEO. V. DU NOYER.

NOTICE OF NEW FOSSILS FROM THE LOWER OLD RED SANDSTONE OF SCOTLAND.—Three localities are referred to in this paper. First, the Den of Cauterland, in the parish of St. Cyrus, on the southern border of Kincardineshire; second, a spot in the parish of Kinnell, near Farnell; and third, a spot in the parish of Craig, near Montrose, both these being in the north-east division of the county of Forfar.

First, in the Den of Cauterland, where there is a considerable development of the basement beds of our Scottish Old Red Sandstone. For many years there has been no quarry wrought in this locality; but as the rock is exposed to decay in a natural ravine, the fossils can be gathered with patience and care. The bottom-bed in the ravine seems to be a coarse sort of grit, through which there is dispersed much limy matter, and in this portion of the beds I have never seen but one fossil, the *Parka decipiens* of Fleming. Above it lies the grey layer, the equivalent, I believe, of the "pavement" beds of Carmybe, Leysmill, and Turin in the neighbouring county, and from it are collected many fossils, such as the *Cephalaspis Lyellii*, the *Parka decipiens* in great abundance, the *Pterygotus anglicus*, and that peculiar and minute crustacean form the *Kampecaris* of Page. Besides the *Pterygotus anglicus*, there are, I think, in this locality several other allied forms of all sizes, from half an inch to many feet. I must be understood as meaning, however, creatures of that size when complete, as our crustacean remains occur in a very fragmentary and scattered condition. The members of the section will remember the gigantic specimen

of *Pterygotus* from Tealing, in Forfarshire, exhibited at last meeting of the Association at Leeds. It consisted of eight large sculptured segments, and it so happens that I have here before me on the table a very small specimen from Cauterland, consisting also of eight segments, and little more altogether than one-third of an inch in length, a minim thus one-sixtieth part the size of its gigantic brother. From this grey layer there are also well-marked Ichthyodorulites, and for a reason which will hereafter appear, I am disposed to attach considerable value to these remains of ancient fishes. Of the vegetable remains from this locality, and which occur in considerable abundance, I can affirm scarce anything with certainty. Though much broken and carbonized, there are what appear to be fragments of coniferous wood, and there is a very common ribbon-like leaf which used to be thought fucoidal. This I have ever been disposed to question, and it so happens that I have met with instances where the leaf terminates in an apparent seed-vessel, very distinct, however, from the *Parka decipiens*. Besides these seed-vessels, which occur separated from the stem, there is another globular body of a beautiful yellow colour, and which presents in the cross fracture a radiated appearance or structure. From this layer also I have pieces of a crinoidal-looking organism, and several things about which it does not even become me to hazard a conjecture. I have now more particularly to notice that these grey beds pass towards the top into a very thin bed, more regularly stratified, and which presents, when laid open by the stroke of the hammer, smooth level surfaces. On the face of these surfaces fossils occur, but as for the most part they are very small, they are not so readily observed. They are, however, if I may so speak, the most exquisite carvings of the extinct organisms. They are the spines or other bony parts of the dermal covering of fishes, and to me they give to this layer the deepest interest, although as yet I have turned out from this locality only detached fragments. I have the fishes to which they belong entire from the locality, to which I am now about to refer.

Second, a spot in the parish of Kinnell, near Farnell station, in the county of Forfar. From one of the beds in this locality I have gathered fossils in excellent preservation and of great beauty. It is a thin shale in which they occur, and I believe it to be the equivalent of the uppermost beds in the section at Cauterland. This locality was unknown to our local geologists, and I cannot describe the feeling with which on one afternoon of the July of the summer time of 1857, I struck out from its stony bed the almost complete picture of a handsome little fish. There it was, with its every spine and its every scale in place, and with what seemed an enamelled head. On further search, I find that it occurs of sizes varying from one inch to something more than three inches. It evidently belongs at least to the family of the Acanthodii. There also occurs here another fish, still more laboriously defended and ornamented. It has two dorsal fins or spines of solid bone, a pectoral spine, a curious arrangement of smaller spines immediately succeeding, what may be called fulcral knobs, like those in the sturgeon, and of a very elegant pattern, a highly finished scale for the head, another scale along the anterior part of the dorsal crest, and scales of minuter form spread over the rest of the body. The reader will pardon my referring so minutely to the different parts of the dermal covering of this little denizen of the ancient seas, when I mention that these are the fragmentary parts of the fishes which occur in the den of Cauterland, and enabling us so far at least to co-ordinate the beds.

In the section at Farnell I have also met with an epistoma of the *Pterygotus anglicus*, and an almost complete example of a *Pterygotus* or *Eurypterus*, I cannot decide which, of about seven inches in length. The *Parka decipiens* also occurs, as might be expected; and there are other minute Crustacean forms. The vegetable remains are rare, but there are numerous Ichthyodorulites; and,

from what I have said, it is important to preserve these, as we may meet with the fishes to which they belong in some other locality. There are still to be mentioned numerous fossil bodies from this locality; some looking like pieces of skin, others evident concretions around a spine or spines, and others, besides, of a coprolite nature. Were the beds more accessible many objects would be found to reward the researches of the explorer.

The third locality is in the parish of Craig, and near the village of Ferryden. The section is a very small patch of thin bedded sandstone, and rests upon and is surrounded on all sides by trap. The flags are very coarse in sort, and have been much changed by heat, but still preserve on some of their surfaces the marks of palæozoic showers and the tread of living things. These footprints are of a lowlier cast than those from the Morayshire beds, but they may be of interest, notwithstanding, as belonging to the older beds of the Old Red. Here, for instance, we have the evidence of the beaches of that very remote period in our world's history. In the large drops impressed on the stone, have we not the proof of the thunder-shower? In the small drops have we not the evidence of the drizzling rain? And there were living creatures on those sands; very humble no doubt, but happy withal. Altogether I can make out about a dozen different kinds of footmarks. In one case it is a *Pterygotus* floundering in the mud; in another instance the crustacean is of smaller dimensions, and is leisurely crossing the oozy beach; and in a third example it is a shrimp-like creature, rapidly traversing the wet sand.

I may here be permitted to make one or two remarks of general character in conclusion. And first, as to the connection of the thin beds with the more common "Cephalaspis" bed of Forfarshire. Upon this point I would not like to speak with anything like dogmatism, but at present I hold them to be part and parcel of one and the same; indeed, I met not long ago, in the Den of Canterland, with what seem to be the spines of one of the small fishes in the same piece of a stone with Cephalaspis head and the crushed segment of a Pterygotus.

Secondly, as to the title of the Old Red Sandstone as a System to an established place in the geological scale. Leaving out of view the English beds, which I do not know, in Scotland alone we can now affirm the existence of a peculiar and I may say extensive fauna and flora at the very commencement of that period; and as we ascend we have the well-known unique fishes and the recently described vegetation of the middle and upper beds. I do hope that you will allow a Scotchman very humbly to speak his mind—that English geologists do not take away from us the good old classical name of Old Red Sandstone.

Thirdly, as to the succession of the different strata, or formations rather, of which the system of the Old Red Sandstone is composed. On this point I am disposed to adhere to the arrangement of Sir Roderick Murchison, adopting as the base or lower formation our Scottish beds which contain the Cephalaspis as their characteristic fossils; as the middle formation, the beds of Cromarty and Caithness with their peculiar fossil fishes; and as the upper formation, the beds of Moray, Perth, and Fife, containing the Holoptychius.

Two entire specimens of fish exhibited by me at the British Association Meeting at Aberdeen, last year, were named respectively by Sir P. Egerton *Acanthodes antiquus*, *Brachyacanthus scutiger*.—REV. HUGH MITCHELL, Craig.

FOSSILIFEROUS LOCALITIES IN MALTA.—DEAR SIR,—I send you a short account of the best localities for fossils in Malta and Gozo; it may be useful to some of your numerous readers.

The upper strata composed of coral-limestone is tolerably fossiliferous; the

best places for collecting are Ras l'Ahrase, Melleo bay, and Port Cercewa, near Marfa, in Malta; and at Fort Chambré and the cliffs at Ramla, in Gozo.

The next stratum consists of a mixture of yellow, black, and green sand in various proportions, and is the one which yields most fossils, although, owing to the soft sandy nature of the rock, many of them are but casts. Ramla cliff, along the north-east coast of Gozo, is by far the best place I have visited; but many can also be got on the coast of Malta, between Port Cercewa, near Marfa and Miggiar, where the great fault reaches the south-west coast.

The next stratum is composed of blue and bluish-white marl; in it fossils are more rare, the only common one being broken specimens of *Pecten Burdigalensis;* however, others are to be found, and the best places are the cliffs under Fort Chambré, in Gozo, between St. Paul's bay and Melleha bay, and at Miggiar, in Malta.

Below the marls there is a series of beds of light yellow sandstone, the common building-stone of the islands, which is rich in echinodermata; the coast between Fort Tigue and St. Julian's bay, Madalena bay, and particularly the large quarries in the centre of the island, near Luca and Micabba are the most productive places. I also obtained a large species of nautilus from Cala Dueira, on the north-west coast of Gozo. Through these beds runs a band of chocolate-coloured pebbles, containing fish-teeth, &c.; it is well developed on the south-side of Fort Chambré, close to the sea, and on the north side of the Wield Cannotta, near the valley of the Salines, in Malta.

The next stratum, which is the lowest, consists of semi-crystalline limestone, and is generally devoid of fossils; on the point between St. George's bay and St. Julian's bay broken specimens of *Scutella subrotunda*, and occasionally teeth may be found, and I procured a nautilus from the cliffs near Krendi, Malta.

At a quarry on the sea-coast at Torre Sciulo, near Krendi, there used to be a fissure filled with breccia, containing mammalian remains; I think it has all been removed now, but others may be expected in the high cliffs on the south-west coast of both Malta and Gozo, and ought to be looked for.

I would recommend any one desirous of making a collection to go to Fort Chambré and ask for a Maltese named Mike; although not very respectable, he knows most of the best localities, is used to collecting, and works well with a pick—no pleasant employment in so warm a climate.—Yours truly, F. W. Hutton, Staff College, Sandhurst.

Nicker Pits.—Dear Sir,—About two miles from Canterbury, in the marshes of West Bere Level, are a number of pools called Nicker Pits. Some of them are very deep, and springs of clear water rise up to the surface, the water finding its way into the marsh ditches, and thus escaping into the river Stour, near the banks of which the pools are situated. Many of them are funnel-shaped in the middle, and when standing on the margin, any one looking into the water can see a long way down. The people in the neighbourhood believe them to be of an awful depth. One man told me that an eel-pot had been lowered into one of the pits seventeen rods, but it did not reach the bottom.

There is some high ground close to the marshes where probably the water which supplies the springs is collected. The soil of the marsh is peaty, and that of the fields adjoining of clay.

The name of these pools, or pits, is remarkable, and makes one fancy that it is connected with some early tradition of our Saxon or Danish forefathers.

Jacob Grimm (Deutsche Mythologie, bb. 456, Zweete Ausgabe), under the article "Nichus," enters somewhat circumstantially into the derivation of the word. *Nichus*, crocodilus. *Nikr*, old Norse for hippopotamus, &c. Mones nl volkslit, s. 140, *Nikker* has the meaning of evil spirit, devil. "Alle nikkers nit de hel." Swedish, *näk, nek;* Danish, *nök, nok*, &c., all express the mean-

ing of a water-ghost or demon. In the Anglo-Saxon the word has the same meaning. Beov. 838, 1144, 2854:—

"And on ydum slog,
Niceras nihtes."

"And on the waves I slew
Nicors by night."

Odinn was called, according to Snarro, Nikarr, or Kniekarr, and when the Scandinavians were converted to Christianity, the god was metamorphosed into the popular Devil, by way of opprobrium. Thus, "Old Nick" became a surname of Odin and the Devil.

J. Kemble, in the glossary to the Anglo-Saxon poem Beowulf, explains the word; thus, Nicor (m) monstrum fluviatile, a nick or nix. Ohd nehhar, whence the name of the beautiful river (the Neckkar) upon which Heidelberg stands. Old Nick, eald nicor Sathanas.

I send you these few imperfect remarks in the hope some of your numerous correspondents may have heard of similar pits in other neighbourhoods; and it will be curious if they bear the same popular name.

The superstitious feeling of the people living near them appears to connect them with something which the Scotch would call uncanny.—I am, dear Sir, yours truly, John Brent, Barton.

Pleistocene Deposits near Liverpool.—Sir,—I have read in your journal Mr. Morton's communication relative to the northern drift, or Pleistocene deposits, near Liverpool.

Mr. Morton says it is "assumed" that the clay, &c., was dropped from melting icebergs. The assumption seems to be a certainty, from the fact that the majority of the fossils found in the Pleistocene beds are common existing species, and all of them such as are of arctic or glacial origin.

On the Cheshire side of the Mersey, between Seacombe and Egremont, there is, as Mr. Morton is doubtless aware, a capital section of the clay and gravel beds. In this clay occurs *Nucula oblonga*, which no longer, I think, finds a place in our recent fauna. It is some years since I examined these beds, but I remember to have found there what does not frequently occur in Pleistocene strata, a ripple-marked surface separating in one place the sands from the clays.

Perhaps Mr. Morton, or some of the members of the Liverpool Geological Society, may be able to confirm this.

Can you inform me where it is possible to obtain a copy of King's Monograph of the Permian Fossils.—I am, yours &c., M. T. R., Darlington.

Professor King's Monograph of the Permian Fossils is one of the publications of the Palæontographical Society. Any of the back volumes can be obtained for the amount of the annual subscription of one guinea. Dr. Bowerbank, of 3, Highbury-grove, is the treasurer.

REVIEWS.

Answer to Hugh Miller and Theoretic Geologists. By Thos. A. Davies. New York: Rudd and Carlton. London: Sampson, Low, Son, and Co. 1860.

For some time past we have had rather a plentiful production of discussive works upon the concordance or non-concordance of the so-termed biblical and geological accounts of creation. We have already questioned, on more than one occasion, whether geologists or theologists are as yet properly prepared

with the necessary data of coming to just conclusions on this interesting topic; but this, however, would not be sufficient reason for the absence of all discussion on the point. We have ever accorded to every opinion, whether we agree with it or not, a fair and just notice, but with the principles of the present book no one could for a moment suppose that we should concur. Written with an evident desire to attain logical deductions and conclusions, our task in reviewing it becomes consequently the more easy, because given any presumed fact as a basis, the truth of the conclusion, if really logically brought out, depends not upon the logic, but upon the actuality and positiveness of the original fact upon which the arguments and deductions are based. We do not admit the basis upon which Mr. Davies attempts to argue, namely, that fossils grow or are naturally produced in particular kinds of rocks and soils, according to an original fiat of the Creator, as animals and plants are from germs and seeds which are developed under their particular and essential conditions. Mr. Davies disputes that fossils are the remains of pre-existing vegetables and animals, and he considers them to belong to the mineral kingdom entirely, and to be developed by a peculiar condition of crystallization—plasticity, as it used to be called, we suppose he means.

Now such a natural resemblance to organic forms by mere crystallizing forces we think few people will be for a moment inclined to seriously consider; but as there may be some to whom the fallacy of this position may not be apparent, we would simply remark that fossils exhibit in themselves the true conditions of what they really are, namely, the solid parts of objects once under the mysterious influences of vitality, which, after the cessation of the vital forces, have been resigned to the action of the crystallizing, chemical, and other forces of the mineral kingdom. Refuting the premises is refuting the principles, and consequently the arguments, however skilful they might be, must therefore necessarily fall; and as Mr. Davies is thoroughly wrong in his basis, his conclusions must be wrong also.

The Old Glaciers of Switzerland and North Wales. By A. C. Ramsay, F.R.S., F.G.S. London: Longman and Co. 1860.

These pleasant chapters formed part of a volume—"Peaks, Passes, and Glaciers"—which we reviewed in our August number of last year, and in which we laid special stress on this portion contributed by Professor Ramsay. In their present pretty pocket-book form, accompanied by a well-defined map of the ancient glacier-regions around the famous Snowdon, they will form an attractive companion and a useful guide to the tourist in this district of Wales.

For the glacier-scenery of Switzerland we need not utter a word, it has only to be seen to be appreciated; and, as Professor Ramsay truly observes, in the writings of De Saussure, Charpentier, Agassiz, and James Forbes the charms of style and graphic illustration have invested glacial investigations with an interest felt far beyond the circle of scientific readers.

Although the glaciers of Wales have long since melted away, and only the marks of their grinding on the rocks in their slow and ponderous passage and the loose debris scattered in the vales and hollows in their dissolution remain to prove their former existence and extent, yet we cannot view such time-honoured relics without a solemn feeling of awe, and a wish to dive deeper into the only seemingly inscrutable mysteries of the past; for how much has given way to man's persevering intellect, and how much more will hereafter yield, by the Divine blessing and consent, to his indomitable energies and intellectual

labours. Heartily in this beautiful summer-time do we wish Snowdon many visitors, and Professor Ramsay's book many readers.

The Geological Examinator. By DAVID PAGE, F.G.S. London and Edinburgh: Blackwood and Sons.

The general excellency of Mr. Page's educational books on geology entitles any new production from his pen to just consideration. If Mr. Page's last work on geological terms contained many errors and some omissions, it was not to be expected that in a subject so full of difficulties a first attempt should prove perfect; but Mr. Page is too careful and pains-taking an author not to avoid a repetition of these casualties in a second edition.

The "Geological Examinator" before us is a little pamphlet of forty pages, usefully filled with generally well selected questions, designed chiefly for the use of teachers in framing their periodical examinations. They are adapted also as an aid for students desirous of acquiring a sufficient proficiency in the science for such general examinations.

To the mere student, self-educating himself in the history of our earth, this useful category presents a succinct epitome of geological science; and if he attempts without reference to his books to answer this series of questions, he will perceive for himself what he has acquired and what he has still to attain before he can regard himself as worthy of being called a geologist.

The Rocks of Worcestershire. By GEORGE E. ROBERTS. London: J. Masters, Aldersgate-street.

Our readers are acquainted with Mr. Roberts' pretty style of writing, from the several attractive communications which from time to time he has contributed to this journal. In this geological history of "The Rocks of Worcestershire" we have a conversational book of much merit and originality. We are introduced at the outset to three important personages—Granitia, Siluria, Triassia—who meet in the arbour of a friend, Hospes, whose acquaintance we thus also make. There these personages narrate what they have to tell us of the past and present condition of that portion of our globe which now bears the denomination of Worcestershire, while Hospes, who is a good listener, puts in an occasional inquiry of very sensible character.

As a rule we dislike dialogues in books, as tending to make them either heavy or puerile; but we must say Mr. Roberts has very well managed to keep up the vivacity and vigour of the narrations throughout, and has rather skilfully made the plan of conversational difference subservient to keeping distinct those topics into which he has divided his work.

Granitia is a fiery, impetuous personage, caring most for the majestic aspect of the rocks and mountains; Siluria finds his pleasure in studying their fossil remains; while Triassia has tales to tell of the natural productions now living upon their surfaces. Hospes, as we have before said, listens; and by his interrogations not only represents to some degree theoretical speculations, but keeps his three scientific friends down to the mark of popular explanation.

Granitia first speaks of the physical rise of the globe, and of the oldest rocks exposed in the county; Siluria follows with a description of their characters, relating also what remains of former animals they contain; while Triassia tells

of the beautiful clothing that makes their ancient masses so enchanting to the eye.

Granitia brings into his account of the igneous rocks the famous Rowley rag-stone, the Shatterford basaltic dyke, Munster's Hill, and the Titterstone *dew-stone*, said by Mr. Roberts, much to our surprise, to be locally called *jew-stone*. Stone-breakers on the roads may by indistinctness of pronunciation give the impression to a stranger of their calling it *jew*-stone, but the correct local term is *dew*-stone. It has acquired this name from its having the property, like other basalts, of condensing on its surface the moisture of the air; hence in damp weather, or when breathed on, it becomes darker in hue, and even sometimes glistens with innumerable beads of water or *dew*.

Siluria, after some remarks on the Cambrian rocks of Wales and the Longmynds, discourses pleasantly first of the Holly-bush sandstone, the black shales of the Malvern, the Lickey quartz-rocks, and other notable strata of Silurian age; secondly, of the Old Red Sandstone-beds; thirdly, of the Carboniferous deposits, up to the coal; then of the Wyre Forest coal-field and the coal-measures; fifthly, of the red-rock above the coal, or the Permian formation; and sixthly, of the New Red Sandstone. The Lias and Oolite then come in for their share of notice; and Siluria finishes his discourse, which is discursively illustrated throughout with occasional excellent descriptions of the various characteristic and rare fossils, with remarks on the post-tertiary period and on modern geological changes.

To Triassia nothing beautiful in the present scenery passes unnoticed; nothing growing, or living on the present surface, from the lichen clinging to the bare rock to the dense forest of luxuriant trees, from the snail or the caterpillar browsing on dock or thistle to the cony burrowing in the quarry-walls of the new red sandstone, but affords him an interesting and amusing topic.

In this bright summer-time, if with any excuse—geological, botanical, or artistical—or with no excuse at all, we should ramble over the beautiful hills and fertile lowlands of Worcestershire, Mr. Roberts' book will be an agreeable and useful companion. Small in size, we may put it in our pockets; and when resting after a morning's walk on stile, felled tree, or road-side heap of stones, as we lazily inhale the fragrance of flowery odours we may read some passages of Granitia's, Siluria's, and Triassia's gossip with pleasure and profit, and perhaps within our reach we may pick up the stone, fossil, plant or insect that has formed a topic in these agreeable conversations. The *dilettante* may think we have not given our excursionist the most luxurious resting-place, but if *dilettante* likes it best, he can read Mr. Roberts' book at home. It may be well read anywhere. But for the geologist what resting-place after a twenty miles walk like a road-heap, where he can rest and luxuriate in his hammerings at the same time? "Politics, love, theology, art, are full of thorns; but when," to apply a humorous quotation from Mr. Reade, "you see a man perched like a crow upon a rock, chipping it, you see a happy dog. The hammerist can jump out of his gig at any turn of the road, and find that which his soul desires. The meanest stone a boy throws at a robin is millions of years older than the Farnese Hercules, and has a history as well as a sermon. Stones are curious things; if a man is paid for breaking them he is wretched, but if he can bring his mind to do it gratis he is at the summit of content."

THE GEOLOGIST.

AUGUST, 1860.

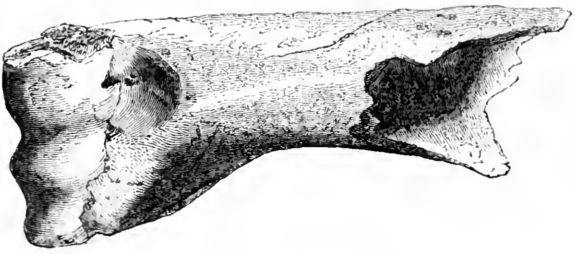
GEOLOGICAL LOCALITIES.—No. I.

FOLKESTONE.

By S. J. Mackie, F.G.S., F.S.A.

(Continued from page 207.)

In our route we shall pass several brick-pits dug into a stiff brown clay or ordinary brick-earth, which must in no way be mistaken for gault, as this fresh-water or marshy stratum, for such the abundance in its lower part of the small white shells of *Helix*, *Succinea oblonga*, and *Pupa* prove it to be, skirts the chalk downs for many miles, apparently into Surrey. At the time when it is extensively dug for



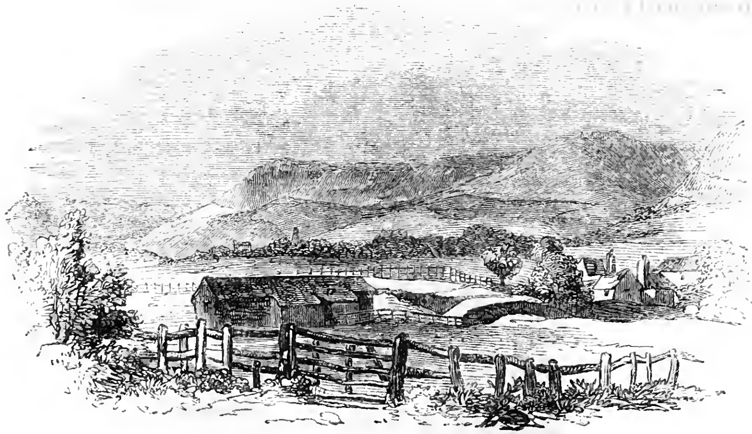
Lign. 29.—Bone of *Bos primigenius*.

brick-making, bones of *Bos primigenius*, *Cervus elephus*, *Bos urus*, and horse are met with. The specimen figured is from one of these pits belonging to Mr. Kingsnorth, of Broadmead.

In some places, as at Brabourne Lees, this brick-earth inosculates

with or merges into great drifts of angular flint-gravel, but in the area we are traversing the brick-earth is very pure and free from any considerable quantity of fragmentary flints.

It must be borne in mind that the plain over which we have been walking, although at the foot of the lofty chalk downs, is still at a



Lign. 21.—Chalk Downs, near Folkestone.

high level above the sea, and forms the continuation of that high ground of the Gault and Lower Greensand at Folkestone, which constitutes the West Cliff, and is cut off from the East Cliff or Copt Point by a valley from eighty to ninety feet deep, in which a considerable part of the old town is built. In this valley several springs of beautifully clear water break out, the most noticeable being that at the "Bull-dog steps," which even in the driest and hottest seasons pours forth in undiminished flow.

At the south-eastern corner of the West Cliff, under the Battery, lying immediately on the upper beds of the Lower Greensand, which are of loose disintegrated sand, is the Pleistocene ossiferous deposit, from one to nine feet thick, to which we alluded at page 125. It consists of flint-pebbles, boulders, and fragments of ferruginous sandstone, intermixed with loamy sand and surmounted by calcareous marl. This bed extends along the face of the cliff for a distance of three hundred and twenty feet, following the irregularities of the

surface of the rock on which it rests, and distinctly displaying the variations in its thickness.

It abounds in the lower part, with the remains of elephant, ox, stag, hyæna, hippopotamus, Irish deer, &c., and, in the marly portion numerous specimens of two or three species of Helix occur.

The shells, however, are found both in the gravel and in the calcareous marl above it, as well as in the cavities of the bones.

Lign. 22.—Bull-dog Steps and Spring, Folkestone.

This ossiferous bed appears to be cut off by the valley, above referred to, towards which it thins out altogether; and no traces of mammalian remains have been found on the east side of the town, except those of Whale in the brick-earth at Porter's saw-mill. On the west it thins off beneath a bed of dark brown brick-earth, such as is found throughout the neighbouring country.

The presence of a breccia of chalk-flints, if it may be so termed,

at this spot is somewhat singular, no flinty chalk occurring at a less distance than six miles to the north or east, and the grey chalk rising between that member of the Cretaceous group and the "bone-deposit," and forming the highest ground of the whole district.

The calcareous marl would appear to have been derived chiefly from the waste of the chalk, the marl possessing all the usual mineral characters of such sediments; a microscopic investigation confirms this view, the marl abounding with *Foraminifera* and other microscopic organisms, many forms of which are immediately recognized as ordinary species of the chalk.

The following are the cretaceous fossils which have been detected in it:—

Terebratula rigida.
Verneuilina tricarinata.
Textularia globosa, trochus, and others.
Polymorphina (?).
Bulimina variabilis and another.
Rosalina.
Globigerina cretacea.
Cristellaria rotulata and another.
Rotalia globosa.
Nodosaria.
Single cells, ovoidal and globula, = Oolinæ (?) and portions of other Foraminifera.
Prismatic fragments of Inoceramus.
Fragments of Echinodermata.
Ossicles of Apiocrinites.
Valves of Cytherella ovata and C. truncata.
—— Bairdia subdeltoidea and B. Harrisiana.
—— Cythere Hilseana.

LIST OF THE ORGANIC REMAINS FROM THE "BONE BED."

MAMMALIA.
Elephas primigenius.
Hippopotamus major.
Rhinoceros hemitœchus.
Bos primigenius.
—— urus.
—— longifrons.
Cervus elephus.
Megaceros Hibernicus.
Equus.
Hyæna spelæa.
Ursus ?.

SHELLS.
Helix nemoralis.
—— concinna.

We have now fairly got back to Folkestone, and if we make the best of our way towards Copt Point, through London-street, we shall pass a good example of the superficial brick-earth spreading over gault and green-sand. I point out this section as, although limited in extent, the little patch of gault there exposed is rather rich in that very elegant and somewhat rare ammonite, *A. Bouchardianus*.

(To be continued.)

REMARKS ON THE DISTRIBUTION OF THE BRACHIOPODA.

By Prof. E. Suess, of the Imperial Mineralogical Museum of Vienna, &c.

[Communicated by Thos. Davidson, Esq., F.G.S.]

In his address to the Geological Society of London, Prof. Phillips has stated that "very slight and trifling, if not mischievous, is that minute industry which, unguided by philosophical reflections, busies itself only with differentials of specimens and abandons the true integration of species, the work of the real naturalist" and from so just an assertion who could dissent; for although it may be necessary to study the characters by which species may be distinguished, still, if an undue importance is given to certain features, or that these are arbitrarily restricted within preconceived limits, and that the more important questions in connection with the distribution and zoological characters of the class in general are overlooked, then, as Professor Phillips so justly observes, but very little good and much harm may be the result of the minute industry of some would-be palæontologists.

Shortly after the publication of the first portion of my Jurassic Monograph, I entered into active communication with Prof. Suess, of Vienna, who had offered me his valued and valuable assistance in the labour I had undertaken, by devoting his serious attention to the Austrian species, and to those fundamental characters by which the class could be subdivided, and so actively and zealously did Prof. Suess pursue his allotted task, that science is indubitably indebted to him for a great many of those important discoveries which deservedly place him among the first few who have really advanced our knowledge in connection with this important class.

In his researches Prof. Suess has constantly aimed at general views; and as those relating to the distribution in time and space have been one of his favourite themes, and upon which he has devoted much attention, I need make no apology while communicating to the readers of the "Geologist" a letter recently received, and in which my distinguished friend has given a brief but concise account of the most prominent results of his enquiry.*

* I may here enumerate the various memoirs published by Prof. Suess upon the Brachiopoda, regretting at the same time that the space which can be devoted to this article precludes the possibility of my enlarging upon their respective merits.

1852.—"On Terebratula diphya." Vienna Acad. 8vo., one plate.

1853.—"On Stringocephalus Burtini." Zool. Soc. 8vo., one plate.

Imperial Museum of Mineralogy, Vienna, April 30, 1860.

My Dear Friend,—I beg leave to submit to your kind judgment the leading views of my second paper on the distribution of Brachiopoda, published by our Academy a short time ago.

In a first paper on this subject, I have tried to unite the facts relating to the geographical and bathymetrical distribution of *living* Brachiopoda, and have arrived at the conclusions: 1st, That the geologically ancient genera (Terebratula, Rhynchonella, &c.), are *sporadic*, and only some genera of newer date (Krausina, Morrisia) may, perhaps, be termed *endemic* genera; 2nd, That Brachiopoda are found living in every climate, but that the genera with translucid shells (Lingula, Discina) are confined to warmer seas; 3rd, That these same genera with translucid shells are only found within very moderate depths, most of them within seven fathoms, the genera with opaque shells (Terebratula &c.) inhabiting, on the contrary, greater depths, with a very small number of exceptions. Some of these latter live even in very considerable depths.

My subsequent papers were intended to give my views on the habitations of fossil Brachiopoda, and so I have given a chapter at the beginning of my second paper, which contains some general remarks on the *life of species*, and on the influence of a change of external conditions on the distribution of animals. It is not this part of my paper I wish to speak of now; if you should wish for it, I might give you an analysis of it in some other letter, and you would find a new classification of our Tertiary beds in it. Before I enter into further details, it is sufficient to extract the following conclusions from this chapter:—1st, A change of level, which produces an extension and communication of marine provinces, will produce diminution and isolation of terrestrial provinces, and *vice versâ*. 2nd, Because the vertical range of bathymetrical zones increases with the depth, an oscillation may produce greater changes in the upper than in the deeper zones. Besides this, the littoral and sub-littoral zones are exposed to certain influences, which do not penetrate into the deeper zones, so that external changes may cause great variation in the upper zones, the fauna of the deeper sea remaining the same.

1853.—"On the Brachial Apparatus of Thecidea." Acad. 8vo., three plates.
1854.—"On the Brachiopoda of Kössen Strata. Acad. 4to., four plates.
1853.—"On the Brachiopoda of the Hallstatt Strata." Acad. 8vo., two plates.
1856.—"German edition of Davidson's Classification of the Brachiopoda." 4to., five plates.
1858.—"On the Brachiopoda of Stramberg Strata in Hauer's Beytrage." 4to., six plates.
1859.—"Note sur la Waldhemia Stephanis in Palaeon." Lomb. 4to., one plate.
,, .—"On the Distribution of Brachiopoda." First paper. Acad. 8vo.
,, .— ,, ,, ,, Second paper. ,, ,,

In addition to these, Prof. Suess has published several other papers relating to the Geology of the Alps, etc.

I presume that the bathymetrical distribution of the great groups of Brachiopoda has ever been nearly the same as it is now, viz., the species with a translucid shell being confined, or nearly so, to the higher zones, and those with opaque shells living in the deeper parts of the sea. It is not necessary to enumerate the numerous cases in which fossil Lingulidæ and Discinidæ have been found, together with ripple-marks, littoral shells, or other signs of shallow sea; nor to point out how rare it is to meet with other Brachiopoda in such conditions. But I must beg you to remember how very predominant hornlike shells of Brachiopoda are in sandstone and shale, and how marked the maxima of Rhynchonellidæ, Spiriferidæ, Terebratulidæ, &c., are in limestone, and more especially in argillaceous limestone. It is a gross error to believe that these families are so frequently wanting in sandstones or shales, because these latter have been formed by a sea too poor in lime for the formation of these shells. MM. Logan and Hunt have taught us that the shells of Lingulæ also consist principally of lime. I believe that the extinct family Spiriferidæ ranges, as I have just remarked, with the other families with opaque shells; but as to the Strophomenidæ you will see that exceptions are somewhat more numerous, most of them belonging to the (restricted) genus *Orthis*. And now let us cast a glance on the distribution of a number of Silurian Brachiopoda, and for the sake of shortness let us call all Lingulidæ and Discinidæ the *Group A*, and all other Brachiopoda the *Group B*, the genus Orthis and a number of other Strophomenidæ being regarded as standing between these groups, Orthis, as you will remark, often offering a very marked tendency associating with group *A*.

In looking, as a first example, at M. Barrande's newest list of primordial fossils in the Bulletin Soc. Geol. xvi., 1859, p 516—546, you may find the following Brachiopoda:—Eight species of Lingula, two Obolus, three Discina, five Orthis, and one doubtful Atrypa. This can only be *Atr. nucula* (Dalne), or *Atr. lenticularis* (Dalne), the first of which, according to M. Barrande, approaches to Obolus or Lingula. The latter surely is one of the Strophomenidæ, and probably an Orthis, So you see that this fauna only offers thirteen or fourteen members of the group *A*, and five or six forms of the genus Orthis. *I cannot believe that this association of Brachiopoda has lived in deep water*, and you know that the predominant rocks in which they are found are sandstones and slates.

In this case it is possible to attain a marked conclusion even in contemplating the primordial fauna of all regions in which it has been found as a whole, but for further studies it is necessary to regard one country after the other. I will select a few examples now, but must, before I do so, say that a part of the conclusions at which I have arrived has been anticipated in a very nice way by the statement of Mr. Sharpe (Quart. Jour, 1848, iv., p. 158), that the genera Lingula and Orbicula, now preferring shallow water, do not offer identical species in the Silurian beds of North America and Europe. I beg you to read the passage of

Mr. Sharpe, because it harmonizes very well with my views on the subject.

I. North America.—*Potsdam Sandstone.*

Professor Hall only cites two Lingulæ and the *Scolithus linearis* here. Professor Rogers is said to have found a Discina. Sir C. Lyell speaks of something resembling a Placuna. The profiles given by D. D. Owen (see Rep. on Wisconsin, Iowa, &c., p. 499, &c.), cite Lingula and Discina in the deepest beds, and the first other genus appearing is *Orthis.*

The *Calciferous sandstone* does not show any marked difference in the character of Brachiopoda. Vanuxem and Hall only speak of a Lingula found in a loose block. Bigsby mentions *L. obtusa* and *Orthides* here.

The *Chazy limestone,* on the contrary, contains ten species of Brachiopoda (according to Hall), one single doubtful one, *Orbicula (?) deformis,* belonging to the shallow water group *A,* the rest having opaque shells, and only embracing one single Orthis.

The *Birdseye limestone* contains no Brachiopoda, according to Hall. The statements of Dr. Bigsby seem to be somewhat contradictory (Quart. Jour., 1858, p. 431 and lists.)

The *Trenton limestone* seems to form a great exception, and to contradict all these statements in containing at the same time a great number of species both of group *A* and of group *B.* Still, in gathering the facts relative to the recurrence of these species in the overlying strata, it may be shown that no contradiction exists. In comparing the lists of Brachiopoda from the Trenton limestone, Utica slate, and Hudson river group, as I intend to do now, it is, I fear, necessary to omit those given in Dr. Bigsby's lists with the authority of Sharpe, because Sharpe united these three strata under the denomination of blue limestone of Ohio, and the species named by him in this bed are cited with his authority as *B* in every one of the three strata. The following species are said to rise from the Trenton limestone into the Utica State, and as no new species of Brachiopoda appears in the State, they form the whole of the species found in it*:—*Spirigerina reticularis, Rhynchonella increbescens, R. modesta, R. bidentata, Strophomena alternata, Orthis lynx, O. testudinaria, Lingula obtusa, L. curta, L. ovata, L. quadrata.* The proportion is much more in favour of group *A* here than in the Trenton limestone. In comparing the Hudson river group, you will find in it:—

a, Species found in Trenton limestone, but not in Utica State: *Lingula crassa, Orthis Tulliensis.*

b, Species passing indifferently through all three strata: *Spirigerina reticularis, Rhynch. increbescens, R. modesta, R. bidentata, Stroph. alternata, Orthis lynx (?), O. testudinaria.*

* Mr. Hall's list cites *Lept. sericea* here for the first time.

c, One species perhaps first appearing in Utica slate: *Lept. sericea.*

d, New species, neither found in Trenton limestone nor in Utica slate: *Discina cultata, D. crassa, D. subtruncata, Orthis centrilineata, O. crispata, O. erratica.*

You easily perceive that the members of group *A* and a number of *Orthides* show other facts of recurrency than the deep sea group *B*, and that they therefore seem to have lived in other conditions, viz., probably in another depth. I might even venture to say more than that. A certain number of shallow-water Brachiopoda of the Trenton limestone reappear in the Utica state; so also do a number of Brachiopoda belonging to a somewhat deeper zone. These latter all pass on into the Hudson river group, but the shallow-water species do not, and are, on the contrary, represented by a number of new shallow-water species. In this case, indeed, I presume *that a change in the littoral or sub-littoral zones has taken place alone*, the fauna of the deeper zones remaining the same.

Above the Hudson river group the beds of sandstone with *Lingula cuneata* and ripple-marks follow.

II. England.

The association of Orthides with species of the shallow-water group *A* is very nice in the deeper Silurian beds. I need only cite Sir Roderick Murchison's and Mr. Salter's statements in Siluria, 3rd edition, pp. 47, 50, and 53, to show that the oldest fossiliferous deposits are very nicely characterized by the association of the genera Lingula and Orthis. In the calcareous Llandeilo beds of Pembrokeshire (Sil. 56), *Lept. sericea* is cited with *Ling. attenuata, L. granulata*, and *Orth. striatula.* I believe it might be of some peculiar interest to study the fossils of those localities, where the calcareous portion of these beds passes into slates. It must be interesting to see the members of deeper zones appearing in this limestone. In comparing the lists of Caradoc and Bala Brachiopoda with those of Llandeilo, as given in Siluria, 3rd edition, and regarding *Spirif. insularis* as an Orthis (Sil., p. 209), you may arrive at the following conclusions:—Eighteen species of Brachiopoda are known in the Llandeilo beds, but all the characteristic genera of the deep sea group *B* are wanting. The species are divided thus: Five Lingula, one Sophonotreta, ten Orthides, two Leptænæ. Of these the following recur in the Caradoc and Bala:—

Of the five Lingula, none.
Of the one Siphonotreta, none.
Of the ten Orthides, seven.
Of the two Leptænæ, both.

The characteristic inhabitants of shallow water, all remain confined to the Llandeilo beds, as well as one-third of the Orthides; on

the contrary, the two single Leptænæ, which may, perhaps, be regarded as inhabitants of a somewhat deeper zone, both recur. Although, according to these lists, the Caradoc and Bala strata contain six Discinæ, four Lingulæ, and one Trematis as true inhabitants of shallow water, they are all different to the shallow-water inhabitants of the Llandeilo beds, as also are the eight Annelida of the Llandeilo different from the eight Annelida of the Caradoc and Bala beds. The fauna of the littoral zone has been changed; the few inhabitants of deeper zones which have been found in the Llandeilo beds rise unchanged in the following beds. I cannot think of speaking more on British Brachiopoda to you. I have only thought these lines necessary for the sake of showing you that the apparent mixture of both groups in your Silurian beds does not seem to me an argument against my views; and as I have now given you two examples in which the shallow-water inhabitants were changed, the fauna of the deeper zones remaining the same, viz., by the comparison of the Utica slate with the Hudson river group, and of the Llandeilo with Caradoc beds. I believe I must point out the very nice example of the contrary given by your uppermost Silurian beds. Here you see the sea getting gradually shallower, and out of about thirty species of Brachiopoda known in the Ludlow beds, you only see a single one rising up into the littoral or sub-littoral passage-beds, and occurring there in great numbers, and that is *Lingula cornea.* Professor Phillips has given a great number of data on these facts, and I see from his paper on the Malverns, that *Rynch. nucula* and *Chonetes lata* sometimes go a good way up, together with *Discina rugata*, but without continuing into the true passage-beds.

III. Bohemia.

Mr. Barrande's Protozoic slates *C*, containing the first or primordial fauna, have hitherto only yielded one *Discina* and one *Orthis* as representatives of our class.

The second or lower Silurian fauna forms Mr. Barrande's *étage D*, which is divided by this gentleman into five minor groups, viz.:—

d 1, Slates at the base of the *étage*, near Komarow.
d 2, Quartzite of Mount Drabow.
d 3, Black, foliated slates.
d 4, Very micaceous slates.
d 5, Yellowish grey slates.

The lower part of this *étage* is very poor in Brachiopoda, *d* alone having yielded the genus *Orthis*. As to *d* 4 and *d* 3, M. Barrande has had the extreme kindness to communicate to me the lists of the Brachiopoda known to him up to the present time from these beds. I see from them that, making abstraction of several incomplete specimens, most of which, according to this distinguished palæontologist, will prove to be *Orthidæ*, *d* 4 has given thirteen species, viz., two or

three *Discinæ*, one *Lingula*, five *Orthides*, two *Leptænæ*, and two doubtful species. You remark exactly the same association of the shallow-water group *A* with the intermediate forms, which I have already pointed out several times.

M. Barrande knows thirteen or fourteen species of Brachiopoda from *d* 5, one of which is *Discina scrobiculosa* from *d* 4, one or two are *Lingulæ*, four *Orthides*, and four other *Strophomenidæ*, among which is the recurrent *Lept. aquila*, and two doubtful species. I need not say that it is again a quite similar association, excluding the formation from deep sea condition. Finally, M. Barrande has a short time ago mentioned a new Lingula in chloritic quartzite belonging to étage *D*.

Now it is the bed *d* 4 which, as M. Barrande has taught us, contains intercalations of slates with calcareous nodules, which have yielded four new species of fossils, four species identical with those of étage *D*, and not less than sixty species which have never been found in *d* 4, nor even in *d* 5, but only in the overlying Upper Silurian étage *E*. Among these sixty species are eleven Brachiopoda: *Terebrat. Daphne*, *T. linguata*, *T. monaca*, *T. obolina*, *T. obovata*, *T. reticularis*, *Spirifer togatus*, *Orthis mulus*, *Lept. euglypha*, *L. patricia*, and *L. Haueri*. Not one member of the shallow-water group *A*, and only one single *Orthis* are among these eleven species, several of which are *Spiriferidæ*; *T. Daphne* is a *Rhynchonella*. In this list the predominance of group *B* is, indeed, very clear.

As, I believe, M. Barrande's suggestion is now generally acknowledged, that the fauna *d* 4, and at least a part of the Upper Silurian fauna *E* must have lived at the same time, I presume, further, that this part of the fauna *E* must have lived in a *somewhat deeper part* of the sea than the contemporaneous littoral or sub-littoral fauna *d* 4 and *d* 5, and I regard these "colonies" as the intercalations of the deposits of a somewhat deeper bathymetrical zone between sub-littoral deposits.

In perusing that highly instructive comparison between the Silurian beds of Bohemia and Scandinavia, which M. Barrande published a few years since, it is seen that the primordial faunæ of both countries consist of very closely representative, but not identical, species.* The same is the case with the second or lower Silurian faunæ, although here, perhaps, a small number of identical species may be found. The comparison of the third or Upper Silurian faunæ yields quite another result, as the number of identical species in both countries is by far greater, although small in comparison to the locality of these faunæ. M. Barrande teaches that with few exceptions (one *Trilobite*, two *Orthocerata*, and a somewhat greater number of Corals), these identical species belong to the class of Brachiopoda, not less than eighteen of which are enumerated as occurring simultaneously in the Upper Silurian beds of Scandinavia and Bohemia. I suppose eight of them to be *Spiriferidæ*, three *Rhynchonellidæ*, and seven *Strophomenidæ*, among which are two *Orthides*. The group *A* is

* Perhaps with one single exception.

not represented; although the genus Orthis is so rich in both countries, it only counts two identical species, and the bulk of the identical forms belongs to the deep-sea group *B*. M. Barrande has suggested that in those cases in which the faunæ are distinct in both countries, a limit between both may have existed similar to that now existing between the Red Sea and the Mediterranean, or between the Atlantic and the Pacific, and that when a greater number of identical species is found, it may be ascribed to the disappearance of this barrier. My view on the subject is different. Supposing that the first and second faunæ are indeed littoral and sub-littoral deposits, the presence of open and somewhat deeper sea will alone be quite sufficient to account for the distinctness of these faunæ, the deep sea forming an almost insurmountable barrier for such beings. Even in the third faunæ only such forms will be found identical in both countries, which have been able to pass over the depths of that Silurian ocean which separated Scandinavia from Bohemia.

Let us for a moment abstract such species as are common to the Bohemia étage *f* and to Scandinavia, and only regard the lower étage *e* of the Bohemian Upper Silurian beds. This deposit offers fourteen species of Brachiopoda, in common with Scandinavia, and, as we have seen above, eleven species in common with the "Colonies." In comparing the lists it is seen, that with the exception of *Spirigerina reticularis* and *Strophomena euglypha,* these two lists contain *different* names. I presume, therefore, that a further bathymetrical subdivision of that Silurian ocean existed, and that at its southern border the littoral and sublittoral zones were inhabited by the fauna *d*4 and *d*5; the next deeper by the species found in the "colonies;" the deepest by those which have proved identical with Scandinavian deposits. *Spirig. reticularis* and *Stroph. euglypha* may have lived in both the middle and the deeper zones.

M. Barrande names about sixty fossils as common to the "colonies" and the fauna *e*. Among these are eight trilobites and other crustaceans, twenty Cephalopoda, twelve Acephala, but only eleven Brachiopoda and one Coral: four Cardiolæ and eight other Cardiacea are found here, together with four Graptolites. The character of the small list of fossils common to the Upper Silurian of Bohemia and Scandinavia is quite different; it contains a single Trilobite, very few Cephalopoda, but eighteen Brachiopoda and several Corals. Brachiopoda of the group *B* therefore, and Corals must, if my view be correct, have formed by far the greatest part of the population of the deeper part of the sea.

Supposed a barrier of land to have existed between Scandinavia and Bohemia, and this to have been destroyed; no cause can be given why merely Brachiopoda and Corals alone have passed the place where it formerly existed. Say, on the contrary, my view to be correct, then localities must be known in which such Brachiopoda and Corals occur alone, or nearly so, and are contained, not in sandstone or shale, but in limestone, and these localities may then be regarded as formed in deep sea. Now such localities are indeed known,

and I need only remind you of M. Gruenewalds' papers on Bogosslowsk. At the locality Petropawlowsk the proportion of the total Brachiopoda and Corals to all the rest of the fossils is twenty-six to one, or nearly seven and a-half to one; at Bogosslowsk eighteen to one, or two. In the middle zone, as given by the fossils common to the "colonies" and *E* in Bohemia, this proportion on the contrary is twelve to forty-eight, or one to four. At Bogosslowsk and Petropawlowsk not one member of group *A* is found; not even a single Orthis.

M. Barrande, in his paper on the parallel between the Silurian deposits of Scandinavia and Bohemia, has shown that during the first periods of animal life, the species were already not universally spread, but distributed according to the same strict rules which regulate the distribution of organic beings in our days. Convinced as I am of the correctness of this view, I venture to add that in remote times also the distribution of the species was not only horizontally but also vertically limited, *i. e.*, that not only geographical provinces but also bathymetrical zones have existed in the Silurian seas.

In closing this abstract, I beg you, my dear friend, to remark, that for the sake of shortness some view may be put forth here too apodictally, which is only enounced as a mere conjecture in my paper, and many an argument in favour of my views has been omitted; I beg also to observe this to any one of your friends, to whom these lines might seem to you worth communicating. Impossible as it is to arrive at decided conclusions by the study of one single class, I have only intended to show that fossils may no more be regarded as mere "dead-born medals," but must always be looked upon as the remains of living beings, the existence of which depended upon a thousand external conditions.

I am, my dear friend,

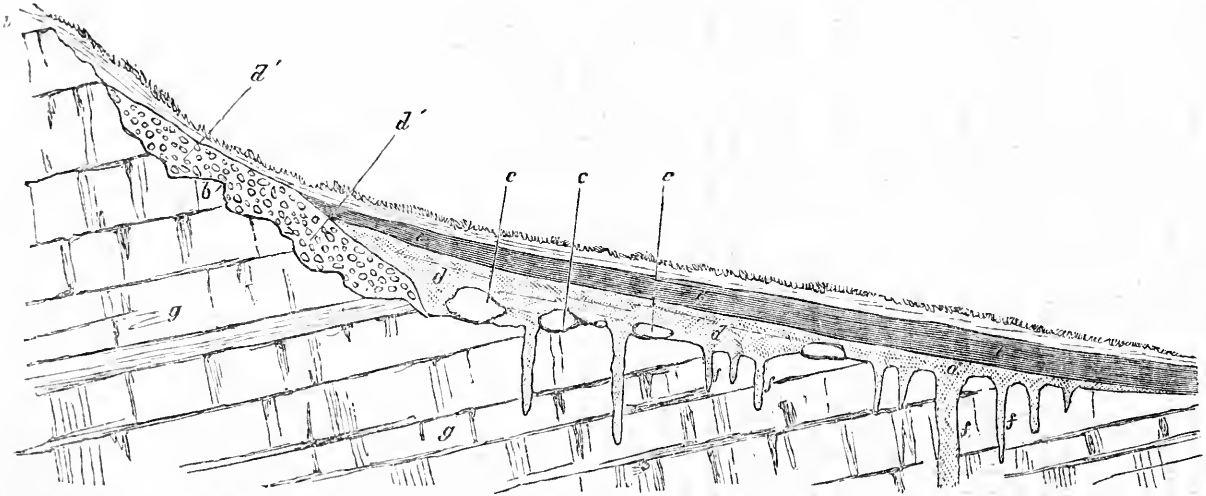
Most truly yours,

To Thos. Davidson, Esq., F.G.S. EDW. SUESS.

ON THE OCCURRENCE OF "SAND-PIPES" IN THE MAGNESIAN LIMESTONE OF DURHAM.

BY J. W. KIRKBY.

DURING the past year my attention has been directed to some curious tube-like cavities in the magnesian limestone near Sunderland, which I believe to be perfectly analogous to the sand- and gravel-pipes of the chalk districts of the south of England and France. And as our knowledge of such pipes has hitherto been almost confined to their occurrence in the chalk, I deem it advisable to describe these in the magnesian limestone; not that they add much to what we already know, or that they afford grounds for a



Lign. 1.—Ideal Section, Showing Site of Sand-pipes, Alluvium, &c.

a, General surface covered with turf; *b*, Worn surface of the limestone, which at *b′* takes the form of a low terraced cliff; *c*, Boulders of mountain-limestone and basalt resting on the surface of the limestone; *d*, Bed of yellow sand; *d′*, Gravel and shingle; *e*, Bed of brown clay without boulders; *f*, Sand pipes; *g*, Magnesian limestone.

new theory of the origin of sand-pipes, but because it is well that the occurrence of such as are found in other calcareous rocks than chalk should be recorded, and especially when in rocks which differ from the latter in general structure and greater hardness.

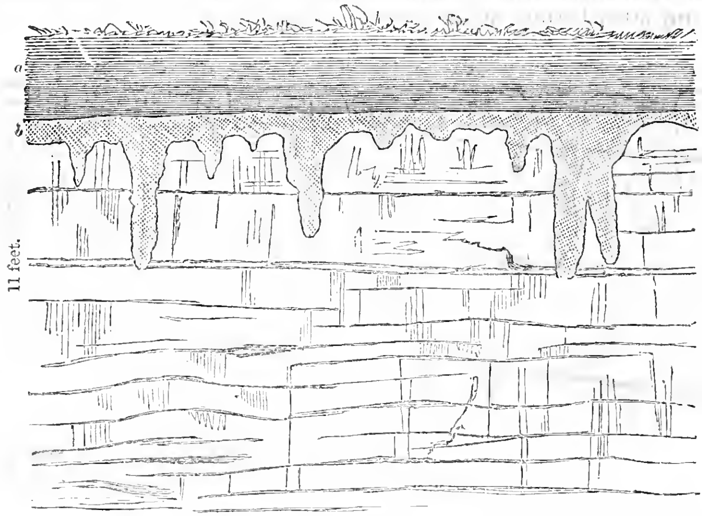
The tubular cavities or pipes, that I am about to notice occur in a new quarry belonging to Sir Hedworth Williamson, which has been lately opened on the northern slope of an eminence of the magnesian limestone called Fulwell Hill, and which is about a mile and a-half north of Sunderland. The summit of the hill is about two hundred and thirty feet above the sea, but the site of the pipes is only about one hundred and fifty feet above that level. The limestone of this hill belongs to the upper portion of the magnesian limestone series, being the upper limestone of Howse, and the crystalline, earthy, and compact limestone of King. This eminence, like most of the surrounding country, is covered more or less with boulder-clay, the covering being comparatively thin on the top, but of greater and increasing thickness on the slopes and lower levels.

On the northern slope of the hill, and at the site of the pipes, the boulder-clay has been removed, and in its place are beds of sand, and clay without boulders, with some shingle and gravel. The limestone surface is also worn here, and has every appearance of having once occupied a position between tide marks—at least, it has the appearance of having been subjected to the action of water. But to properly understand the relation of these beds to the limestone surface, and to the pipes in the latter, I refer to the accompanying woodcut (fig. 1), which gives a transverse section of the deposits I am describing.

The contour of the general surface is given by the line *a a*, and the worn surface of the limestone by *b b*, which at *b′* takes the form of a low terraced cliff, the ledges being smoothly rounded, and in some places rather hollowed out beneath. Against the face of this cliff is piled an irregular mass of gravel and shingle, the pebbles being chiefly from the magnesian limestone, with others derived from the boulder-clay, some of the former being sub-angular. Very little order is to be observed in the arrangement of the gravel, it being heaped against the rock just as we sometimes see gravel thrown against the base of a cliff on recent coasts: some of the pebbles are coated with *calc sinter*. Immediately upon the surface of the limestone, and occasionally in slight hollows of it, are large boulders, *c c*, of mountain limestone, basalt, and other rocks, which are most undoubtedly the heavier boulders of the boulder-clay originally covering this surface, the greater weight of which has enabled them to withstand the denudative forces which removed the rest of that deposit from this area*. Upon the surface of the limestone, and

* This is the case where the drift, or boulder clay, is now being denuded on the Durham coast. I know of several instances of the kind in the neighbourhood of Sunderland, one of the best occurring about two miles or more to the north of the harbour, on a level tongue of limestone called Whitburn Steel. Scattered over its surface are some dozens of large boulders of mountain-limestone, magnesian-limestone, millstone-grit, and basalt, the majority being par-

covering the boulders just mentioned, is a bed of yellow sand, *d d*, that becomes rather ferruginous inferiorly; this bed is thickest where it abuts against the gravel, and decreases in thickness as the surface slopes, until it thins out and disappears; its maximum thickness is about six feet, its breadth about fifty yards; where it is thickest, thin seams of brown clay, and more rarely of carbonaceous matter like coal-drift, are interspersed through its mass; and occasionally towards its lower portion are small lenticular beds of gravel. Above

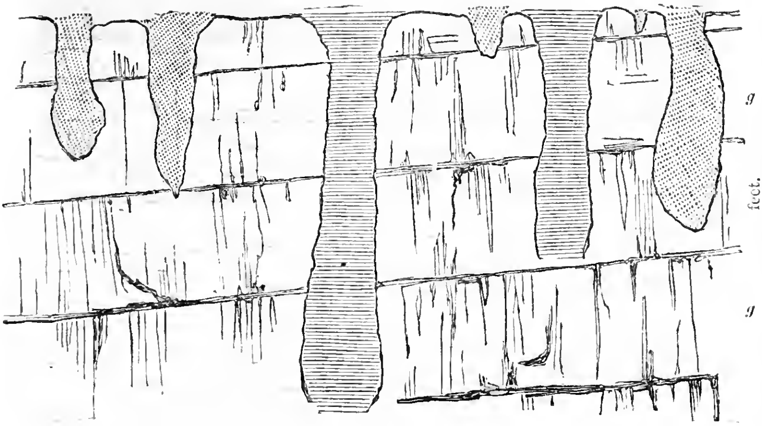


Lign. 2.—*a*, Clay; *b*, Sand; *c*, Limestone,

the sand is a bed of brown clay, *e e*, which increases in thickness as the surface slopes, being thinest where the sand is thickest, the upper portion graduating into the soil. The united thickness of these beds of alluvium is not more than nine feet where thickest, usually much less.

tially covered with marine parasites, and several are lodged in slight hollows. And though I have known this locality for many years, and have almost a personal acquaintance with some of the boulders, I have never observed indications of any of them having shifted their position. Indeed, it is astonishing to observe how little, or rather how slowly the boulders are affected by the surf; there are some whose distance from the cliff is indicative of the period that must have elapsed since they were washed out of the clay, which still retain an angularity of surface; and there are others which have laid on the beach for years—where not scoured by sand or gravel—that have not yet lost their striated surfaces. In the cliff or bank of clay other large boulders may be seen ready to drop out, and at the base of it, or in close vicinity, are others which have lately fallen, to whose number every winter's frosts and storms make additions.

The pipes are found in the limestone beneath the sand beds. I have never noticed them where the sand is absent; and though they are sometimes filled with clay, or a mixture of clay and sand, yet in these instances a thin layer of sand is always the immediate cover of the limestone. Nevertheless, the quarrymen assert that pipes have occurred in other parts of the hill where the limestone is immediately covered by the boulder-clay. They do not occur towards the higher portion of the slope where the gravel is piled against the face of the limestone; nor further up where the limestone is merely covered with turf; nor have they as yet been noticed in any other locality of the magnesian limestone.



Lign. 3.—Sand- and Clay-pipes on North Side of Quarry, the Alluvium removed.

a a, Pipes filled with sand; *b b*, Pipes filled with clay; *g g*, Thick-bedded, crystalline, and concretionary limestone. Some of the pipes in this figure do not show their true terminations.

The general form of the majority of the pipes is tubular (figs. 1 and 2), but often irregularly so; some few are conical, but such are usually of slight depth; others seem to be modifications of these forms; occasionally they are almost flask-shaped (fig. 3), and in some instances, by the coalescence of two pipes, they appear to be bifid.

The depth of the longest is about twelve feet, but in one case the termination was not reached at this depth. The depth of the majority is within six feet; but there are pipes of all depths from one foot to twelve.

Generally their width is proportionate to their depth, though in this they do not observe much uniformity. It is curious to observe the irregularity of width of some, especially of those I have termed flask-shaped. Such pipes are of less width a foot or two below their apertures than towards each extremity, the lower portion of the tube being the most capacious. In some pipes I have noticed a

sudden increase of width at certain beds, as though the substance of such strata was easier removed than that of others. Indeed, the unequally worn surface of the limestone composing the sides of the pipes seems indicative of the same thing; for, on removing the internal core of sand or clay, and so exposing this surface, it is invariably found, so far as I have examined, to be unevenly worn, some beds, or portions of beds, standing out in relief, and others being deeply corroded all round the circumference. The widest pipe I have seen was about two feet across, but most of them are under twelve inches. Transverse sections are usually more or less circular, oval, or ovate, the diameter of course varying in different directions.

Though, perhaps, the most of the pipes are excavated straight into the limestone, yet several are more or less oblique. The most remarkable instances of this kind are represented in fig. 4. In more than one instance I have actually seen pipes which change the direction of their original course, so as to become in a measure slightly angulated. I cannot but think that the direction of both the latter pipes and those whose courses are oblique must have been determined by some pre-existing fissure or other weakness in the limestone, though in these instances I have seen no indication of any such fissures.

The pipes are usually filled with sand from the bed overlying the limestone, but sometimes with sand and clay; and occasionally a great portion of the core is composed altogether of clay of an unctuous and tenacious character, and which often contains numerous remains of small vegetable roots, or the perforations once occupied by such roots; in fact, so thoroughly perforated are the cores of clay sometimes by the minute ramifications of these roots, that I almost believe that they would be quite pervious to water in spite of the impermeable nature of the clay composing them.

(To be continued.)

BRITISH ASSOCIATION MEETING.

THE Meeting of the British Association opened on the 27th of June, at Oxford, under the presidency of Lord Wrottesley.

The President, in his address, offered some admirable remarks on astronomical matters, and on the progress made in chemical science. On geology his remarks were chiefly confined to the interesting topics of the earliest human remains, associated with those of extinct mammalia. We give this part of his address entire.

"The bearing of some recent geological discoveries on the great question of the high antiquity of man was brought before your notice at your last meeting, at Aberdeen, by Sir Charles Lyell, in his opening address to the Geological Section. Since that time many French and English naturalists have visited the valley of the Somme in Picardy, and confirmed the opinion recently published by M. Boucher de Perthes, in 1847, and afterwards confirmed by Mr. Prestwich, Sir C. Lyell, and other geologists, from personal examination of that

region. It appears that the position of the rude flint-implements, which are unequivocally of human workmanship, is such, at Abbeville and Amiens, as to show that they are as ancient as a great mass of gravel which fills the lower parts of the valley between those two cities, extending above and below them. This gravel is an ancient fluviatile alluvium by no means confined to the lowest depressions (where extensive and deep peat-mosses now exist), but is sometimes also seen covering the slopes of the boundary hills of chalk at elevations of eighty or one hundred feet above the level of the Somme. Changes, therefore, in the physical boundary of the country, comprising both the filling up with sediment and drift, and the partial re-excavation of the valley, have happened since old river-beds were, at some former period, the receptacles of the worked flints. The number of these last, already computed at above fourteen thousand in an area of fourteen miles in length, and half a-mile in breadth, has afforded to a succession of visitors abundant opportunities of verifying the true geological position of the implements.

"The old alluvium, whether at higher or lower levels, consists not only of the coarse gravel with worked flints above mentioned, but also of super-imposed beds of sand and loam, in which are many fresh-water and landshells, for the most part entire, and of species now living in the same part of France. With the shells are found bones of the Mammoth and an extinct Rhinoceros, *R. tichorhinus*, an extinct species of deer, and fossil remains of the horse, ox, and other animals. These are met with in the overlying beds, and sometimes also in the gravel where the implements occur. At Menchecourt, in the suburbs of Abbeville, a nearly entire skeleton of the Siberian Rhinoceros is said to have benn taken out about forty years ago, a fact affording an answer to the question often raised, as to whether the bones of the extinct mammalia could have been washed out of an older alluvium into a newer one, and so redeposited and mingled with the relics of human workmanship. Far-fetched as was this hypothesis, I am informed that it would not, if granted, have seriously shaken the proof of the high antiquity of the human productions, for that proof is independent of organic evidence or fossil remains, and is based on physical data. As was stated to us last year by Sir Charles Lyell, we should still have to allow time for great denudation of the chalk, and the removal from place to place, and the spreading out over the length and breadth of a large valley of heaps of chalk flints in beds from ten to fifteen feet in thickness, covered by loams and sands of equal thickness, these last often tranquilly deposited, all of which operations would require the supposition of a great lapse of time.

That the mammalia fauna, preserved under such circumstances, should be found to diverge from the type now established in the same region, is consistent with experience; but the fact of a foreign and extinct fauna was not needed to indicate the great age of the gravel containing the worked flints.

Another independent proof of the age of the same gravel and its associated fossiliferous loam is derived from the large deposits of peat above alluded to, in the Valley of the Somme, which contain not only monuments of the Roman, but also those of an older stone period, usually called Celtic. Bones, also, of the bear, of the species still inhabiting the Pyrenees, and of the beaver, and many large stumps of trees, not yet well examined by botanists, are found in the same peat, the oldest portion of which belongs to times far beyong those of tradition; yet distinguished geologists are of opinion that the growth of all the vegetation, and even the original scooping out of the hollows containing it, are events long posterior in date to the gravel with flint implements—nay, posterior even to the formation of the uppermost of the layers of loam with fresh water shells overlying the gravel.

The exploration of caverns, both in the British isles and other parts of Europe, has in the last few years been prosecuted with renewed ardour and

success, although the theoretical explanation of many of the phenomena brought to light seems as yet to baffle the skill of the ablest geologists. Dr. Falconer has given us an account of the remains of several hundred hippopotami, obtained from one cavern, near Palermo, in a locality where there is now no running water. The same palæontologist, aided by Col. Wood, of Glamorganshire, has recently extracted from a single cave in the Gower peninsula of South Wales, a vast quantity of the antlers of a reindeer (perhaps of two species of reindeer), both allied to the living one. These fossils are most of them shed horns; and there have been already no less than one thousand one hundred of them dug out of the mud filling one cave.

In the cave of Brixham, in Devonshire, and in another near Palermo, in Sicily, flint implements were observed by Dr. Falconer, associated in such a manner with the bones of extinct mammalia, as to lead him to infer that man must have co-existed with several lost species of quadrupeds; and M. de Vibraye has also this spring called attention to analogous conclusions, at which he has arrived by studying the position of a human jaw with teeth, accompanied by the remains of a mammoth, under the stalagmite of the Grotto d'Arcis, near Troyes, in France."

The Papers read in the Geological Section were :—

Professor Phillips.—"On the Geology of the Vicinity of Oxford."

J. F. Whiteaves, Esq., F.G.S.—"On the Invertebrata Fauna of the Lower Oolites of Oxfordshire."

Edmund Hull, Esq., F.G.S.—"On the Blenheim Iron-Ore, and the thickness of the formations below the Great Oolite at Stonesfield."

Rev. P. B. Brodie, F.G.S.—"On the Stratigraphical position of certain species of Coral in the Lias."

Rev. H. B. Tristram.—"On the Geological characters of the Sahara."

Rev. J. P. B. Denis, F.G.S.—"On the mode of flight of the Pterodactyles of the Coprolite bed near Cambridge."

Dr. Daubeny.—"Remarks on the Elevation Theory of Volcanos."

T. Sterry-Hunt, Esq.—"Notes on some points in Chemical Geology."

W. Pengelly, Esq.—On the Geographical and Chronological Distribution of Devonian Fossils in Devon and Cornwall."

Dr Wright.—"On the Avicula contorta bed, and Lower Lias in the South of England."

Joseph Prestwich.—"On some new Facts in relation to the Section of the Cliff at Mundsley, Norfolk."

Dr. Geinitz.—"On Snow Crystals observed at Dresden."

—————.—"On the Silurian Formation in the district of Wilsdruff."

Professor Harkness.—"On the Metamorphic Rocks of the North of Ireland."

Captain Woodall.—"On the Intermittent Springs of the Chalk and Oolite of the neighbourhood of Scarborough."

Sir R. I. Murchison.—Exhibited New Geological Map of Oxford.

Dr. Anderson.—"Report on the Dura Den excavations."

M. A. Favre.—"On Circular Chains in the Alps."

Professor Jukes.—"On the Igneous Rocks interstratified with the Carboniferous Limestone of the Basin of Limerick."

C. Moore.—"On the Contents of three square yards of Triassic Drift."

Rev. S. R. Smith.—"On the Bone Caves of Tenby."

Baron Francesco Anca.—"On two newly discovered Ossiferous Caves in Sicily containing Marked Flints, &c."

Rev. W. Lister.—"On some Reptilian Foot-prints from the New Red Sandstone, North of Wolverhampton."

Rev. Prof. Sedgwick.—"On the Geology of the Neighbourhood of Cambridge, and the Fossils of the Upper Greensand."

Rev. W. V. Harcourt.—"On the Effects of Long Continued Heat—shown in the Iron Furnaces of the West of Yorkshire."

Prof. Rogers.—"On some Phenomena of Metamorphism in Coal in the United States."

Prof. Ferdinand Von Hochstetter.—"Some Observations upon the Geological Features of the Volcanic Island of St. Paul, in the South Indian Ocean, Illustrated by a Model in Relief of the Island, made by Capt. Cybulz, of the Austrian Artillery."

——— ———— ——— —————.—"Remarks on the Geology of New Zealand, illustrated by Geological Maps, Drawings, and Photographs."

Rev. J. C. Clutterbuck.—"On the Course of the Thames from Lechlade to Windsor, as ruled by the Geological Formations over which it passes."

Alphonse Gages.—"On some Transformations of Iron Pyrites in connection with Fossil Remains."

William Molyneux.—"Remarks on Fossil Fish from the North Staffordshire Coal Fields."

W. Powrie.—"On the Old Red Sandstone and its Fossil Fish in Forfarshire."

Sir P. Egerton.—"On a New Form of Ichthyolite discovered by Mr. Peach."

E. Hull.—To Explain the Six-inch Maps of the Geological Survey.

Rev. W. Symonds.—"On the Selection of Peculiar Geological Habitats by some of the Rarer British Plants."

Rev. Dr. Whewell and Prof. Tennant.—On the Kohinoor previous to its cutting."

Dr. W. S. Lindsay.—"On a Recent Volcanic Eruption in Ireland."

Sir D. Brewster.—"Details respecting a Nail found in Kurgoodie Quarry."

J. A. Knipe.—"On the Tynedale Coal-Field and Whinsill."

Rev. J. Dingle.—"On the Corrugation of Strata in the Vicinity of Mountain Chains."

J. Price.—"On Slickensides."

The following are the chief Papers of geological bearing read in the other Sections:—

Captain Sherrard Osborn, R.N., F.R.G.S.—"On the Formation of Oceanic Ice in the Arctic Regions."

Rev. F. O. Morris.—"On the Permanence of Species."

Professor Daubeny.—"Remarks on the Final Causes of the Sexuality of Plants; with particular reference to Mr. Darwin's work 'On the Origin of Species by Natural Selection.'"

Professor Ferdinand von Hochstetter (Vienna), Geologist of the Austrian Novaro Expedition.—"A new Map of the Interior of the Northern Island of New Zealand, constructed during an Inland Journey in 1859."

Captain Sir Edward Belcher, R.N., C.B.—"On the Manufature of Stone Hatchets and other Implements by the Esquimeaux, illustrated by native Tools, Arrow-heads, &c., &c."

Dr. James Hunt.—"On the Antiquity of the Human Race."

Professor Macdonald.—"On the Homology of the Vertebrata, and its importance in Zoology."

J. A. Brorn.—"On the Velocity of Earthquake-shocks in the Laterite of India."

————.—"On the Magnetism of certain Indian Granites."

Canon Moseley.—"On the Motion of Glaciers."

Professor Buckman.—"Report on Experiments on the Alteration of the Specific Forms of Plants by Culture."

J. Gwyn Jeffreys, F.R.S.—"Exhibition of Opercular Monstrosities of *Buccinum undatum*."

Professor Carus.—"On the Value of Development in Systematic Zoology and Animal Morphology."

G. Ogilvie, M.D.—"On the Hard Tissues of Fern Stems."

Dr. Ogilvie.—"On the Woody Fibres of Flowering and Cryptogamic Plants."

Prof. Hennessy.—"On the possibility of Studying the Earth's Internal Structure from Phenomena observed at its Surface."

"Prof. Pierce.—"On the Physical Constitution of Comets."

Mr. W. R. Birt.—"On the Forms of Certain Lunar Craters indicative of a Peculiar Degrading Force, with Diagrams."

P. Lutley Sdlater, F.L.S.—"On the Geographical Distribution of Vertebrates."

NEW GEOLOGICAL MAP OF THE NEIGHBOURHOOD OF OXFORD.

On Saturday the 30th June, Sir R. I. Murchison drew the attention of the Section to the maps of the neighbourhood of Oxford just completed by the Geological Survey, and accompanied by explanatory memoirs. The area embraced the whole series of formations from the "Woolwich and Reading series" of the Tertiary system (Prestwich) to the Lower Lias, and included the towns of Banbury, Woodstock, Farringdon, Wantage, Thame, with Oxford about the centre (sheets 13, 45 south-west, 45 north-west). This district had been surveyed by Messrs. Hull, Whitaker, Polwhele, and Bauerman.

Mr. Hull then proceeded to give a rapid sketch of the most interesting points recorded in the maps, dwelling particularly on the iron-producing beds of the Lias, the fragmentary distribution of the Portland and Lower Cretaceous groups, particularly the sponge-gravels of Farringdon. With reference to the fresh-water iron-sands of Shotover Hill, it was shown that they were entirely isolated from the marine beds of the Lower Greensand period, which range from Culham by Nuncham to Tool-Baldon. After much consideration, it was deemed the less hazardous course to colour the fresh-water beds of Shotover as Lower Greensand, under the supposition that they may be an estuarine and marginal portion of that formation. At the same time, recollecting

the opinions of Fitton, Conybeare, and more recently of Professor Phillips, who on a previous occasion had stated reasons strongly in favour of the Wealden age of these beds, the course adopted by the geological surveyors could only be considered provisional.

ON THE BLENHEIM IRON-ORE AND THE THICKNESS OF THE FORMATIONS BELOW THE GREAT OOLITE AT STONESFIELD, OXFORDSHIRE.

By Edward Hull, B.A., F.G.S.

The economic importance of the Liassic and Oolitic iron-ores is yearly on the increase, owing to three causes—the expansion of the British iron-trade; the local curtailment in the supply of the clay ironstone of the coal-measures; and the extension of the railway system, which has rendered available iron-ores far removed from the boundaries of the coal-fields, and which were almost unknown till within the last few years. From the "Mineral Statistics of Great Britain," collected by Mr. Hunt, it appears that in 1857 the quantity of ore raised from the Cleveland, Whitby, and Northamptonshire districts reached the amount of nearly one and a-half million of tons, or nearly one-tenth of the total quantity raised in Great Britain. It may safely be predicted that ere long Oxfordshire will also rank as an iron producing county.

Blenheim Iron-Ore.—The existence of highly ferruginous beds in the direction of Banbury and Deddington has been known for some years back, and they have to a small extent been quarried for smelting. There are two varieties, a *siliceous ore*, occurring at the top of the sands, which form the lower zone of the Great Oolite, and a *calcareous ore*, forming the upper rock-bed of the marlstone, or Middle Lias. During the progress of the Geological Survey in the neighbourhood of Woodstock, the existence of this latter ore was ascertained in several places, but in particular along the valley of the Cherwell, west of Charlbury.*

Geological position.—The Blenheim ore is identical in geological position and almost in its nature with the Cleveland ore of Yorkshire. It forms the rock-bed at the top of the Marlstone, which in Gloucestershire and elsewhere produces the tabulated promontories which jut out from the flank of the oolitic escarpment. At Fawler it rests upon soft sands, comprising the lower division of the Marlstone, and is surmounted by the clay of the Upper Lias. It varies in thickness from ten to fifteen feet, and is of nearly uniform composition throughout, except where there occur bands of fossils, with an excess of carbonate of lime. The shells are Marlstone species, as *Rhynchonella tetrahedra*, *Terebratula punctata*, &c.

Mineral character.—At the outcrop the rock presents a rich ferruginous aspect, but when reached at positions where it has been protected from atmospheric influences, its colour is deep olive green; and the gradual change may be observed in blocks newly split. In its latter state it appears to be oolitic under the lens.

The character of the ore, before oxydization is probably that of carbonate and silicate of iron, the latter imparting the green tinge: when exposed, it passes into a hydrated peroxide of iron. The quantity of silica is about 12 per cent., and of lime 10 per cent. Phosphoric acid is only present in minute

* As this ore extends under the property of the Duke of Marlborough, I have called it "Blenheim ore;" and for further details refer to the "Geology of the country round Woodstock." Mem. Geol. Survey: 1857.

quantity—0·55 per cent. From an analysis of nine samples made in the Museum of Practical Geology, the average quantity of metallic iron was found to be about 32 per cent.

The outcrop of the rock may be traced along the valley of the Cherwell, at Fawler, on the property of the Duke of Marlborough, where it is now being quarried for transport to South Staffordshire; and it is expected that upon the completion of the Worcester and Hereford Railway large quantities will be sent into the iron-districts of South Wales.

Thickness of the Formations below the Great Oolite, at Stonesfield.—For the purpose of ascertaining the depth of the iron-bed below the Stonesfield Slate, the Duke of Marlborough directed one of the slate pits to be continued downwards till the ore was reached. This has not been accomplished, for on reaching, at a depth of one hundred and twenty feet, the Upper Lias Clay, the water flowed in so plentifully that the sinking had to be abandoned. With the assistance of a very interesting section at the west side of the railway opposite Fawler, we can easily complete the series of strata down to the Lower Lias.

Section in Slate Pit at Stonesfield.

			Thickness.
Great Oolite.	Upper Zone.—White limestone resting on calcareous shales and marl with *Ostrea Sowerbyi*.		10 feet
	Lower Zone.—Sandy flags, slates, and shelly oolite, with a band of "Stonesfield Slate at 10 feet from the top. *Trigonia impressa*, &c.		80 feet
Inferior Oolite.	Upper Ragstone or zone of Ammonites Parkinsonii (Wright)	Coarse-grained rubbly oolite, with *Clypeus Plotii*, *Lima gibbosa*, *Trigonia costata*, &c.	30 feet
Upper Lias Clay, at Fawler			6 feet
Marlstone.	1.—Iron-ore or rock-bed		10 to 15 feet
	2.—Sands with concretionary nodules of iron-ore		15 to 30 feet
Lower Lias.—Thickness unknown; but, judging from analogy with the above formations, not very great.			

If we compare the development of these formations in this part of Oxfordshire with that which they attain in Gloucestershire, we shall find that there is a great diminution in volume when traced from their north-western outcrop towards the south-east of England. On former occasions I have endeavoured to show that all the Lower Secondary Formations undergo a similar degree of attenuation from the north-west towards the south-east, in which direction they ultimately disappear. This will be illustrated by the following table of comparative thicknesses in Oxon and Gloucestershire:—

Comparative Thickness of Formations.

		Gloucestershire. Thickness in feet.	*Oxfordshire.* Thickness in feet.
Inferior oolite		264	30
Upper Lias	Sands	20—50	Absent.
	Shale	380	6
Marlstone		250	25
Total		944	61

The thicknesses of the strata in Gloucestershire are derived from an accurately measured section in the north flank of Bredon Hill, except in the case of the Inferior Oolite, which is taken from Leckhampton Hill. The thickness of strata in Oxfordshire is taken at Stonesfield. It embraced the region extending from Banbury on the north to the range of the Chalk formation south of the Thames valley, and from Farringdon on the west to Thame on the east, Oxford occupying a central position. Mr. Hull then gave a rapid sketch of the formations from the Lower Lias up to the Tertiary deposits of the Woolwich and Reading series, which had been surveyed by himself and his colleagues, Messrs. Whitaker and Polwhele, dwelling more especially on the position of the iron-beds of the Marlstone, the distribution of the Portland series, and the Lower Cretaceous strata which occur in detached outlying areas of small extent, and evinces the extent of the denudation at several periods.

The positions of the fresh-water iron-sands of Shotover Hill, which had on a previous day been lucidly described by Professor Phillips, were pointed out, and the reasons were stated which had induced the officers of the Geological Survey to refer these strata provisionally to the Lower Greensand, though it was by no means intended to undervalue the arguments of Fitton, Conybeare, and Phillips in favour of the Wealden age of these isolated groups.

SUMMARY OF PAPER ON THE GEOLOGICAL SYSTEM OF THE CENTRAL SAHARA OF ALGERIA.

By Rev. H. B. Tristram, M.A., F.G.S., &c.

On leaving the Atlas crest, and descending its southern slopes, we soon come upon the secondary rocks, which are the prevailing formation of the whole country between the Atlas and Laghouat. This district for about four hundred miles due south is rocky, and with mountain-ranges running for the most part in parallel lines north-east and south-west. The southern slopes of the Atlas chain rise from a depression which in several parts, especially to the south of Tunis, is many feet below the level of the Mediterranean. From this depression the Sahara is for the most part a system of endless terraces, some of which are only a few miles apart, while others are expanded into plains of from 50 to 100 miles in width, and which, so far as my observations and the information I could gather from native caravans and a trustworthy guide, extended in an unbroken series to within three days' journey of Timbuctoo, when the traveller will probably find himself on the northern watershed of the valley of the Niger.

As we advance, on every stage is written the record of the retiring ocean, which gradually, by the elevation of its southern shores, was driven back and back to the northward, till the last long inlet from the gulf of Cabes to Tuggurt was drained and evaporated, leaving its traces in the salt plains, and occasional moisture of the Wed Rhir and Cholt el Melah—the ancient Lake Tritonis.

There are several singular exceptions to the course of the mountain-ranges above mentioned, which are generally the local causes of the oases.

Thus at Laghouat we find several elliptical basins of diminishing size piled one on another. The lowest and largest rests on the flat surface of the secondary rock, which is the base of the shale system. Several great fissures which pervade all these super-imposed basins, allow the water to percolate. It

then rests on the impermeable rock, draining through a very thin stratum of gravel or sand into any depressions, whence it is raised by artesian wells, and creates an oasis.

From the Sebaa Rons to Laghonat, all these ranges appear to belong to the lower chalk formation. Limestone predominates, and forms the ridges of the Sahari, Senalba, and Djellal mountains. It is of saccharoid structure, and of a variable colour, generally greyish white. In many of the plains there is sandstone, sometimes hard, and at other times so soft as to yield to the pressure of the fingers. This sandstone encloses nodules of flint of various colours and semi-transparent. By dis-aggregation they become detached from the softer medium in which they were embedded. As the wind sweeps the sand they form shingly beaches of pebbles, many of them of a pretty chalcedony, which is exported in some quantity to Paris.

The upper deposit of limestone is marked by regular beds of gypsum of vast extent, which are found in every district of the Sahara, but never in the secondary formation of the Atlas region.

South of Laghonat, the furthest French outport, we came upon a shallow alluvial deposit of the very latest tertiary and diluvian formation. Near the mountains this is often composed of rolled pebbles in a limestone matrix. On the plains it is a white calcareous rock, a sort of crust very hard at the surface, but soft and friable below, where it is mixed with green or grey clay, and encloses many crystals of gypsum.

The diluvian formation may be traced more or less distinctly, I believe, between all the ranges, even as far north as the Zahrez, near Djelfa.

I was particularly struck by the fact that several of my fossil shells from these superficial deposits proved specifically identical with fresh-water tertiary fossils from the region of the Black Sea. May not further research perhaps reveal that at no very distant geologic epoch a vast chain of fresh-water lakes, similar to those of North America at the present day, extended from the plateaux of the western Sahara as far as the neighbourhood of the Caspian?

The basin of the M'zab country further still to the south supplied me only with a few fossils, apparently miocene.

In turning from the M'zab southwards to Waregla, and thence north-east towards Tuggurt and the Gulf of Cabes, the geological system appears to be the same, but with fewer distinct little basins, and with more extensive diluvian deposits.

As far as we could trace them, the basins are generally horizontal up to Biskra in the north, and Gufza in the east, or very slightly inclined, consisting of alternating beds of greensand (?), gypsum, and clay. These beds extend almost without interruption, or with very slight depressions, from latitude thirty-one degrees north to thirty-five degrees north, and from longitude five degrees east to nine degrees east.

The most interesting portion of this district is the Wed R'hir, a long line of depression sloping from the Touareg desert, latitude thirty degrees north, and longitude five degrees east (circitu), with its surface occasionally moistened by salt lakes, but without any springs of fresh water, yet affording at intervals throughout its whole extent a never-failing supply of sweet water, through artesian wells penetrating the upper limestone. An immense population is supported by this Wed R'hir, which is for many days' journey one continuous line of oases, such as El Marier, Tamerna, Tuggurt, Temaçin, and after a further interval, in which its traces are lost, it reappears in the oases of N'Goussa and Wangla, and gradually is lost in the highlands of the south. But it is probable that even here the subterranean course of the water can be traced, and that the Touareg owe their means of subsistence to their knowledge of wells on this line.

The Wed R'hir terminates in the Chott Melr'hir, a depression probably eighty feet below the Mediterranean sea-level, and the lowest point of the whole Sahara. This basin extends eastwards to the Chott el Melah (Lake Tritonis), at a greater elevation, but yet scarcely rising to the sea-level, from which it is separated by some thirty miles of sand-hills and rocks.

Proceeding northwards of the Melr'hir, we rapidly lose all traces of the diluvian deposits, and come upon the chalk, chalk-marl, and greensand in regular succession, dipping generally southwards. The three southernmost ridges of the Mons Aures, viz., the Djebel Checha, the Dj. Khaddon, and Dj. Amar, present us with these three stages of the cretaceous group in order.

When we advance to the north of Biskra, the boundary between the Till and the eastern Sahara, the mountains are composed of masses of nummulite limestone, with bands of gypsum and occasional irruptions of rock-salt, mixed with layers of marl. One of these mountains of rock-salt has been described long since by Dr. Shaw—that of El Outaia.

There are many salt deposits, sometimes masses of isolated rock-salt, perfectly pure, of many hundred yards in circumference, as at Hadjera el Mehl, (or Rochers de Sal), more frequently in the form of layers or incrustations on the plains near the Chotts, or beds of evaporated lakes. Some of the isolated rock-salt hills have been suggested to have been eruptions of argillaceous mud, gypsum, and rock-salt across the secondary and tertiary deposits.

In such a country as the Sahara, we cannot expect to find much mineral wealth, beyond the salt, gypsum, and natron. There is a quarry of oxide of manganese in the Djebel Trisgrarine, traces of lignite and carbonized trees at Ain el Ibel, and may hot springs—some pure, others strongly impregnated with chlorine. The temperature of one of these I found to be one hundred and twenty-five degrees Fahrenheit, of others from seventy-five to ninety-five degrees Fahrenheit. In one of the latter were swarms of a little fish, *Cyprinodon dispar,* also found in the warm springs of Egypt.

ON THE INVERTEBRATE FAUNA OF THE LOWER OOLITES OF OXFORDSHIRE.

By J. F. Whiteaves, F.G.S.

The author remarked that, although the physical geology of the neighbourhood of Oxford was, with some exceptions, tolerably well understood, comparatively little was known with respect to its palæontology, especially that part relating to the invertebrate division of the animal kingdom. The only exception he was aware of was a detailed list of the fossils of the Stonesfield slate in the volume of Oxford Essays for 1855, by Professor Phillips, and to this list the author was enabled to add twenty-seven species of shells, which he enumerated.

Near the Kirtlington Station, on the Great Western Railway, several fine sections of the upper beds of the Great Oolite are remarkably well exibited; and in deep cuttings on the Oxford, Worcester, and Wolverhampton railway, between the Handborough and Charlbury Stations, the lower beds of the same formation may be conveniently studied. The fossils procured from these beds, including the Stonesfield-slate, were one hundred and thirty-five species, of which one hundred and twenty-eight were shells, four echinodermata, three corals, and one Bryozoon. This list seemed to the author especially interesting, as tending to remove the isolation of the Minchinhampton fauna, and to prove that shells, &c., previously detected only on the Cotswolds, were

in reality widely distributed throughout Great Britain. The same zoological features characterized both the Great Oolite of the Cotswolds, and the same formation in the neighbourhood of Oxford, these features being principally the rarity of the cephalopoda, and the comparative abundance of carnivorous univalve shells. Five of these shells had not previously been detected in this formation, and eight were new to science. Mr. Whiteaves then read a list of the fossils of the Forest Marble and Cornbrash, collected at Islip and Kidlington. These lists comprised one hundred and twenty-six species. With regard to the Cornbrash, he remarked that a careful study of the fossils of that formation, whether in Oxfordshire, in Yorkshire, to on the Cotswolds, seemed to him by no means favourable to the theory of Professor Buckman, that the Cornbrash assemblage of fossils, on the whole, more closely resembles the series from the Inferior than that from the Great Oolite. Comparing the collection formed in Oxfordshire with the fossils of the same formation at Scarborough, as catalogued by Mr. Bean, we see that, although there exists a general resemblance, yet, on the whole, this is not so great as we might have supposed, and that each district possesses several species apparently peculiar to it—many Yorkshire species being probably absent in Oxfordshire, and vice versâ. Ammonites and Belemnites are remarkably rare, too, in both the Cornbrash and Forest Marble. Mr. Whiteaves has in his cabinet upwards of three hundred species of fossils, in the finest preservation, collected by himself in the neighbourhood of Oxford: of these, thirty species are new, the majority of which are about to be published by the Palæontographical Society.

ON SOME REPTILIAN FOOTPRINTS FROM THE NEW RED SANDSTONE NORTH OF WOLVERHAMPTON.

By Rev. Wm. Lister.

The object of this paper is simply to announce the discovery, not so much of new fossil-remains, as of some already known, but found in a fresh locality; some of them are, however, believed to be new. They consist of foot-prints of the *Cheirotherium*, or *Labyrinthodon*, the *Rhyncosaurus*, and of another animal, with which the author is not acquainted, but which he is inclined to think was a bird.

Hitherto the remains of the Labyrinthodon have only been found in Warwickshire and the north of Cheshire,* and the Rhyncosaurus in the Grinshill quarry, near Shrewsbury. The remains now discovered have been met with in Staffordshire, in a quarry of the New Red Sandstone, just within the borders of the Red Marl, which caps the quarry, at a place about six miles north of Wolverhampton, in the parish of Brewood, on the road between "The Stone House" and Somerford. "The Stone House," which is given on the Ordnance Map, is near to Chillington Avenue Gate, and within two hundred yards of the quarry. The bed in which they occur is about twelve feet from the surface. One of the slabs was so thickly covered with foot-prints resembling those of the Rhyncosaurus as necessarily to convey the idea that the animals which made them must have been very numerous on the spot. These were smaller than most of the others of the same kind, being only from three-fourths of an inch to an inch in length. This slab was unfortunately removed before I had an

* This statement was corrected by Mr. Hull, of the Government Survey, who named two or three fresh localities in which the remains of the Labyrinthodon have been discovered, but the names of these places have not, as I understood, been published.

opportunity of re-examining it, but I have a strong impression that the tracks were those of a number of young animals, they were so very uniform in size and shape.

Some of the foot-prints of the Labyrinthodon are ten inches in length, those of the Rhyncosaurus are from one to two inches. The latter vary a good deal in shape, the toes, three in number*, of some of them being straight, while others are curved outwards, like a bird's claw, half-closed, and then pressed down laterally on a flat surface. The nail, which is very distinct, is broad in proportion to its length, hooked, and sharp at its point, and turned out in the same direction as the toe. When questioned at Oxford as to whether the author had detected any signs of articulations or phalanges, he answered in the negative; but on re-examining the impressions, he is strongly inclined to think that the latter may be seen, and that they are three in number in the outer toe, but he feared to speak of the others. Most of the footprints terminate somewhat abruptly behind, but one of them is prolonged in that direction, more, however, in the shape of an elongated heel than of a hinder toe.

In all these foot-prints, which, though differing somewhat in form, he regards as those of Rhyncosauri. The outer toe is invaribly the longest, the second somewhat shorter, and the third shorter still. But in one of the impressions this is not the case, the middle toe being the longest, as in the case of birds, and he is therefore strongly inclined to think that the impressions are really those of a bird; but the toes are broader in proportion to their length than are those of birds generally, being one inch and five-eighths in length, and five-eighths of an inch in breadth, the two side toes being broader than the middle one. There is another impression which much resembles this, four inches behind it, measuring from the back of the one to the front of the other, and he believes both belong to the same animal; but the second has been somewhat interfered with by the foot-prints of another animal which has crossed it, and he cannot thus speak positively upon the point, but he believes he may affirm that these two are single and alternate.

He has recently learnt from the workmen engaged in this quarry that the same, or similar impressions have been also found in another quarry about a mile distant from this, but he has not yet seen them.

It may be added that the ripple-marks are very beautifully preserved on some of the slabs, and so are also the imprints of rain-drops; while in many cases the amount of sand deposited by each tide is readily discovered by the thickness of its layers, which lie one on the other, and which, by means of the ripple-marks, show also the direction of the wind, or the currents of water, at the time they were deposited.

ON THE GEOGRAPHICAL AND CHRONOLOGICAL DISTRIBUTION OF THE DEVONIAN FOSSILS OF DEVON AND CORNWALL.

By W. Pengelly, F.G.S.

The author stated that if we adopt the classification of Professor Sedgwick†, we have, in the districts under consideration, what, as a matter of convenience, may be called five fossiliferous Devonian areas, namely, a deposit of the age of the "Plymouth group" in each of the districts, South Devon, North Devon, and Cornwall, and one of the "Barnstaple" age in each of the two latter.

* On a slab of Red Sandstone, in the Manchester Museum, there are footprints which much resemble these, but in which the toes are *four* in number, the side toe, as in the present instance, being the longest, and the other three each shorter than the other.

† Quar. Jour. Geol. Soc., vol. viii., p. 3—14.

Throughout his paper he spoke of them as "Lower South Devon, Lower North Devon, Lower Cornwall, Upper North Devon, and Upper Cornwall," but stated that he applied the terms "Upper" and "Lower" to the rocks of Devon and Cornwall as a matter of convenience merely, and not as embodying or implying any opinion respecting the co-ordination of these rocks, with deposits of the Devonian age elsewhere.

Eighty-seven per cent. of the fossil species found in them are peculiar to one or other of the five areas. Ranged in the order of their specific fossil wealth, whether total or peculiar, they stand thus, in descending order: Lower South Devon, Upper North Devon, Upper Cornwall, Lower Cornwall, and Lower North Devon. There is a greater number of species common to Devonshire and the Devonians of strata of continental Europe than to the five areas. If the entire number of species found in the district under consideration, be put as = one thousand, we have twenty-one derived from the Silurian, eight hundred and six peculiar to the Devonian, and one hundred and seventy-three which passed over to the Carboniferous age.

The latter part of the paper was occupied with the discussion of various hypotheses respecting the cause of the peculiarities of distribution which had been described.

ON THE AVICULA CONTORTA BEDS, AND LOWER LIAS OF THE SOUTH OF ENGLAND.

By Dr. Thomas Wright, F.R.S.E., F.G.S.

The object of this paper was to show that the beds known as the "black shales with the bone-bed" which rest upon the grey marls of the Keuper contained a fauna which was special to them, and that many of the species were identical with those found in the Upper St. Cassian beds of Germany, and the Kassen strata of the Tyrol. Dr. Wright described detailed sections of the "Avicula cortorta beds" at Garden Cliff, near Westbury-on-Severn, which he considered as the best type in England, at Wainlode cliff on the Severn, at Aust cliff on the Severn, at Penarth near Cardiff, and at Watchet near St. Quartock's head, the railway cuttings at Uphill and Saltford, and sections of the same beds at Binton and Wilmcote, in Warwickshire, were described. Nearly the same physical conditions prevailed in the deposition of all these beds. The fauna was limited as to the number of species, but abundant as to individuals. *Pecten Valoniensis (Defr.), Avicula contorta (Portl.), Cardium rheticum (Mor.), Pollastra arenicola (Strick.),* were found in nearly all these beds. The "bone-bed" was likewise well exposed in many of these localities. The fishes of the "bone-bed" had long ago been referred by Prof. Agassiz, Sir Philip Egerton, to species which were found in the Trias, and the Molluscous fauna, as far as it was known in England, was special to this zone, for these reasons many geologists consider the "Avicula contorta beds" as the upper fossiliferous portion of the Trias rather than as the basement beds of the Lias. The question was an interesting one, inasmuch as fossil mammalian teeth of *Microlestes* had been found in the "bone-bed" of Germany many years ago, and recently Mr. Moore had discovered them in a deposit of the same age near Frome.

The Lower Lias may be divided into six zones by the ammonites contained in each of these sub-divisions; the lowest, No. 1, contains *Ammonites planorbis* (Sow.) in great abundance; this zone is well exposed at Street, in Somersetshire, at Up Lyme, near Lyme Regis, at Watchet and Penarth, and in Warwickshire and Gloucestershire in several localities, all the fine Enaliosaurian

remains from Street, now in the British and other museums, were collected from this zone, together with the remarkable *Plesiosaurus megacephalus* (Stritch), of which only two specimens were known, the one contained in the Bristol Museum, and the other in the Warwick Museum.

The zone of *Ammonites angulatus* (Schoth.), which forms so important a subdivision of the Lower Lias of France and Belgium, and contains in these counties so rich a fauna, is represented in England by a few characteristic ammonites only, it is exposed in the Harbury cutting near Warwick, from whence most of our specimens have been obtained.

2nd. The zone of *Ammonites Bucklandi* is well exposed in the Church cliff of Lyme Regis, in the Harburg cutting, in various sections in Somersetshire, as at Saltford, and near Bath, and in Gloucestershire and Glamorganshire. This zone contains many species of Ammonites, as *A. Bucklandi*, *A. rotiformis*, *A. Greenoughi*, and *A. tortilis*, and *A. Conybeari*, with *Lima gigantea*, and *Gryphæa arcuata*.

3rd. The zone of *Ammonites Turneri* contains many of the Lyme Regis saurians, as *Ichthyosaurus platyodon*, associated with *Am. semicostatus* (Y. and B.), and *A. Bownardi*, and *Pentacrinus tuberculatus* (Mill).

4th. The zone of *Ammonites obtusus* is best shown at Lyme Regis, between Broad Ledge and Cornstone ledges, near Charmouth. Its beds are very fossiliferous; here are found *Am. obtusus*, *A. stellaris*, *A. planicosta*, and *A. Dudressieri*. This zone was exposed in Gloucestershire, in the cuttings of the Bristol and Birmingham railway, and at Bredon, in Worcestershire, a large assemblage of its cephalopods was found.

5th. The zone of *Ammonites oxynotus* is found near Black Venn, at Lyme, and in the vale of Gloucester, *Am. oxynotus*, *A. bifer*, *A. lacunatus*, lie in this zone.

6th. The zone of *Ammonites raricostatus* is well seen at Lyme Regis, in the vale of Gloucester, and at Robin Hood's bay, in Yorkshire. The beds belonging to this and the preceding zone are very ferruginous, and many of their fossils are preserved with difficulty.

Hippopodium ponderosum, *Gryphæa obliquata*, and a thin band of corals occupy the upper beds. With these are associated many other mollusca and *Pentacrinus scalaris*. *Am. armatus*, *A. dentinodus*, and *A. raricostatus* lie together in the lower beds of the zone.

ON THE METAMORPHIC ROCKS OF THE NORTH OF IRELAND.

By Professor Harkness, F.R.S.

On referring to the geological map of Ireland, by Sir Richard Griffiths, Bart., it will be seen that a large area in the north of Ireland is occupied by rocks of a metamorphic nature. These rocks, well exhibited in the county of Donegal, are composed of mica-schists and quartz-rocks, which are seen occupying well-marked districts in this part of Ireland. These mica-schists and quartz-rocks are subject to great contortions, and have a prevailing south-east dip in the north of Ireland. The relative position which these rocks bear to each other is well seen in a section of about twenty miles along the coast, between Inishowen head and Mulin head, the extreme north point of Ireland. Although the mica-schists and quartz-rocks are several times repeated in this section, the result of great flexures and contortions, the section shows that quartz-rocks are the oldest rocks of this portion of Ireland, and that they are conformably overlaid by the mica-schists. An anticlinal axes occurs among these metamorphic rocks a little south of Mulin head, and on the north side of this axis,

where the higher strata reposing on the quartz-rocks are seen, flaggy gneiss occurs, the representatives of the rocks termed mica-slate on the south; but which, from the abundance of chlorite contained in them, have a greater affinity to the chlorite slates of the south-west of the Grampians than to true mica-slates. The arrangement and lithological nature of the rocks in this portion of Ireland bear great resemblance to the higher members of the quartz-rocks with their succeeding flaggy gneiss of the west of Sutherland, as described by Sir Roderick Murchison, and induce the conclusion that in the former area the equivalents of the latter occur.

ON TWO NEW OSSIFEROUS CAVES DISCOVERED IN SICILY IN 1859.

By Baron Anca de Mangalviti.

Since the fourteeth century caves containing fossil bones have been known in Sicily; but these were regarded up to the sixteenth century as belonging to giants, the supposed first inhabitants of the island. The caves which have hitherto been explored are six, to which are now to be added two others discovered by the author in 1857. The locality of one of these caves is Mondello, at the northern extremity of Mount Gallo, to the west of the city of Palermo. It bears the name of Grotta Perciata, because it is hollowed out from both sides. The exposure of the cavern is towards the north-east; its length twenty-four metres; its breadth thirty metres; its elevation above the sea forty-nine metres; and its distance in a straight line from the shore one hundred and sixty-seven metres. The mountain is of Hippiorite limestone, like the other mountains which encircle the basin of Palermo. It was known that the cave contained fossil terrestrial and marine shells, but it was not suspected that it contained also fossil bones until the author found them after very careful search. He found also, mixed with the bones and shells, flints and agate having the form of weapons, apparently of human workmanship.

The animals to which the fossil remains belong are the following:—

Mammalia.—One or two species of deer; hog (probably *Sus scrofa*); a soliped pachyderm (probably an ass).

Birds.—A species undetermined.

Marine Shells.—*Patella ferruginea* or *Lamarkii*, *P. vulgata*, *Monodonta fragarioides*, *Murex brandaris*, *Fusus ?*

Land Shells.—*Helix aspersa*, *H. Mazzullii*, *H. vermiculata*, *Bulimus decollatus*.

The second and most interesting cave exists in the north part of Sicily, near the village of Acque Dolce, and exactly at the foot of Mount San Fratello. It is known under the name of the "Grotte San Teodoro." Its entrance is exposed to the north-east, and its elevation above the sea-level is sixty-five metres; its distance from the shore one thousand forty-one metres. The rock of which Mount San Fratello is composed is also Hippurite limestone, but at the base of the hill, not much more than ninety-seven metres from the shore, and ten metres above the sea, is seen a limestone which the author suspects to belong to the Post-pliocene formation. The cave penetrates into the interior of the mountain to a depth of seventy metres. Its width at the entrance is fifteen metres, but it enlarges to nineteen metres in the middle. The roof is high and sloping, but without any appearance of "chimneys" or openings passing outwards to the exterior of the mountain. The floor of the cavern, from a wall at the entrance to the extremity, rises 10.90 metres. This height in a great measure arises from fragments of rock fallen from the roof, which have accumulated from forty-four metres to the end of the cave.

The author had the good fortune to discover in this grotto a rich deposit of fossil bones comprising all the fossil Post-pliocene fauna of Sicily. But that which renders this discovery highly interesting is the finding, 1st, of entire jaws with their canine and molar teeth—the first evidence of the existence of carnivora in Sicily; 2nd, a fragment of a molar apparently of *Elephas Africanus*, the existence in Sicily of which animal is confirmed by another fragment of a molar from the "Grotte de l'Olivella."

Lastly, in the "Grotte de San Teodoro" there have been found abundantly stone-weapons of trachytic and phonolitic rocks, the form of some of which do not permit us to doubt their human workmanship. I may remark here that the stone-weapons as yet found in Sicily have been only found in those places where the remains of deer and hog are accumulated. In the rich collection made from this cavern, the author, with the aid of M. Lartet, has determined the following species :—

CARNIVORA.—Spotted Hyæna; Bear, resembling the brown bear of the Alps (*Ursus arctos*); dog, wolf, fox, species much smaller than that of France.

RODENTS.—Porcupine, Rabbit.

PACHYDERMS.—*Elephas antiquus, E. Africanus; Hippopotamus*, two species; *Sus*, probably *Sus scrofa*, resembling the *Sus* of the north of Africa; a soliped, probably an ass.

RUMINANTS.—Ox, of middle stature; ox, small and lank; deer, one or two species; sheep, or an allied ruminant.

BATRACHIANS.—Large frog.

BIRDS.—Small species undetermined.

MARINE SHELLS.—*Ostrea larga, Cardium edule.*

LAND SHELLS.—*Helix aspersa.*

COPROLITES of hyæna.

Also STONE WEAPONS.

ON THE SELECTION OF PECULIAR GEOLOGICAL HABITATS BY SOME OF THE RARER BRITISH PLANTS.

By REV. W. S. SYMONDS, F.G.S.

The author requested the aid of his brother naturalists on the above interesting subject, and remarked that he would be especially obliged by any communications from geologists and botanists during the ensuing summer and autumn.

He is engaged with his friend, the Rev. Mr. Purchas, in preparing a work on the botany and geology of the county of Hereford, and had lately been struck with the selection of peculiar geological habitats by some of the rarest of our plants. He visited the rocks of Stanner, near Kingston, last month, in company with his friend Captain Guise, and found a certain band of the Stanner rocks clothed with *Geranium sanguineum* and *Lychnis viscaria*. They also found the very rare *Scleranthus perennis*. Now *Lychnis viscaria* grows only in five out of the eighteen botanical provinces into which England and Scotland have been subdivided. Stanner rocks are hypersthene greenstone, and *Lychnis viscaria* has selected to grow upon a black basaltic dyke. It has also selected a similar habitat on Salisbury Crags. *Scleranthus perennis* grows only in two provinces in England and Scotland. It is remarkable that it should be found on the isolated trap rocks of Stanner with *Lychnis viscaria*, associated with *Geranium sanguineum*, neither of which are found within many miles of the Stanner traps.

Lathyrus Aphaca and *Lathyrus Nissolia* have been very abundant this year on the Keüper sandstones and marls, but Mr. Symonds has not seen a single specimen of the former plant upon the adjoining Lias of the district. *Carex montana* grows only on carboniferous limestone. The rarer plants of Snowdon appear to have selected bands of volcanic tuff, intermingled with calcareous deposits for their habitat. Mr. Symonds particularly asked for the attention of geologists to the Flora of insulated trap rocks.

ON THE CORRUGATION OF STRATA IN THE VICINITY OF MOUNTAIN RANGES.

By the Rev. J. Dingle.

This paper was in continuation of some former papers which had been read before the Association, in which an attempt had been made to determine the mode of the formation and development of the earth's crust, from physical, geographical, and geological considerations. The author described the varying forms of flexure, diminishing in intensity with their distance from the igneous axis, which characterizes the strata in the neighbourhood of the mountain chains, and showed how this form would arise from the action of the molten interior of the earth near the fissures in the crust. The fluid lava rising in a fissure must have reacted on the general mass beneath, and caused an upward pressure on the crust on each side. Now it has been proved by experiment in the case of a column of fluid, that, in the propagation of the condensation produced by the weight of the column, there were points of maximum and minimum pressure along the surface of the fluid from which the column arose; and hence in the case of the fissures we might generally expect successive corrugations, subsequently lifted up, and sometimes falling over at last into one dip, just as we actually find them. The author expressed his obligations to Professor H. D. Rogers for the valuable information which he had derived from an important paper of his on the subject in the Transactions of the Royal Society of Edinburgh for 1857, but demurred to some of his hypotheses. Flexures at definite points in solid strata must be produced by repeated and continued fissures, and not by paroxysmal action. The latter chiefly spends itself in earthquakes and volcanos, which, upon the whole, can produce no continuous change of form. The two kinds of forces appear, however, to be intimately related to each other; and if we suppose the one to be only the other in excess, we are supplied with a simple explanation of the connection between the corrugated mountain chains, and the lines of earthquakes and volcanos.

As a corollary from the above views, it might be observed that they destroyed the idea of any distinct theory of volcanos, whether of elevation or eruption; for the quantities of elevated and ejected matter in the case of a fissure or a ruptured corrugation might be in all possible proportions to each other.

The author expressed his confidence that in this and his former papers he had pointed out the true means of determining the mode of formation of the earth's crust from the consideration of existing facts and well-known physical laws—a branch of geological science in which nothing had been done before beyond starting a few crude and ill-supported guesses.

A brief conversation followed the reading of the paper, in which Professor Rogers expressed his general acquiescence with the author's views on some important points connected with the formation of the earth's crust.

ON THE TYNEDALE COALFIELD AND WHINSILL.

By J. A. Knipe.

The Tynedale coal-field is of no very great extent, but from its being a prolongation of the true Northumberland and Durham coal, though at the distance of forty miles west of the great deposit, saved by the great ninety fathom fault, which is so well exposed on the coast at Callercotes, and as it is entirely ignored in the Geological Society's Map, and every other, excepting the author's, he thought it should be recorded in the reports of the meeting of the British Association. The proprietor of the Tynedale coal-field is the Earl of Carlisle, and the coal is worked to a great extent by Messrs. Thompson, of Kirkhouse, near Brampton, who also work the Talkirs mines in Cumberland.

The pit is called the "King Pit," "Midgeholme Colliery," and is situated on the north side of the Fault, which has been proved to be a down-throw to the north of one hundred and eighty fathoms, and as the mountain limestone of Aldstone Moor is in juxta-position with the coal, the author conceives that the down-throw here must be considerably greater. The shaft is five hundred and six feet deep, and the aggregate thickness of the five seams or beds of workable coal is twenty-three feet. Below the coal are thick beds of sandstone, shale, and grit; then thick beds of limestone; then comes the coal of Blenkinsop mines; again other intervening strata, succeeded by the thin beds of coal of Holtwhistle in shale and sandstone; then intervene coarse sandstone, a thin bed of coal and grit, succeeded by rich ironstone nodules in thick beds of shale. Again come thick beds of coarse sandstone and limestone, reposing on interstratified trap—the great Whinsill.

The Whinsill of Wall Town, near the Roman camp, Amboglanna Bardoswold, offers here a bold bluff escarpment to the north of near one hundred feet in height. Portions of it assume a rude columnar structure; it is, however, much obscured by foliage. The Roman wall, which is here very perfect, and six feet in thickness, crosses the summit of the escarpment. The Whinsill is traceable to the German Ocean, and is seen again interstratified with the carboniferous limestone of Dunstonburgh Castle.

ON THE CONTENTS OF THREE CUBIC YARDS OF TRIASSIC EARTH.

By Charles Moore, Esq., F.G.S.

From the extraordinary series of organic remains exhibited to the Section by the author, and from the importance attaching to the mammalia, the reading of this paper excited considerable interest. The author stated that several years ago he suspected the presence of Triassic rocks in the neighbourhood of Frome from accidentally finding in a roadside heap of carboniferous limestone a single block of stone containing fish remains of the former age, but that for a long time he was unable to discover it *in situ*. More recently, when examining some carboniferous limestone quarries near the above town, he observed certain fissures which had subsequently been filled up by a drift of a later age. One of these was about a foot in breadth at the top, but increased to fifteen feet at the base of the quarry, thirty feet below, at which point teeth and bones of triassic reptiles and fishes were found. Usually these infillings consisted of a material as dense as the limestone itself, and from which the organic remains

could only be extracted with difficulty. In another part of the section he was fortunate enough to find a deposit consisting of a coarse friable sand, containing similar remains. In order that this might receive a more careful examination than could be given to it on the spot, the whole of it, weighing about three tons, was carted away to the residence of the author, at Bath, a distance of twenty miles, which was then passed under his observation with the following results:

The fish-remains, which were the most abundant, were first noticed. Some idea might be formed of their numbers when he stated that of the genus Acrodus alone, including two species, he had extracted forty-five thousand teeth from the three cubic yards under notice, and that they were even more numerous than there numbers indicated, since he rejected all but the most perfect examples. Teeth of several species of *Sauricthys* were also abundant, and next to them teeth of *Hybodus*, with occasional spines of the latter genus. Teeth and scales of *Lepidotus*, and scales of *Gyrolepis* were also numerous, as also were teeth showing the presence of several other genera of fishes. With the above were found a number of curious bodies, each of which was surmounted by a depressed enamelled thorn-like spine, or tooth, in some cases with points as sharp as that of a coarse needle; these the author supposed to be spinous scales belonging to several new species of fish allied to the *Squaloraia*, and that to the same genus were to be referred a number of minute hair-like spines, with flattened fluted sides, found in the same deposit. There were also present specimens hitherto supposed to be teeth, and for which Agassiz had created the genus *Ctenoptychius*, but which the author was rather disposed to consider, like those previously referred to, to be the outer scales of a fish allied to the *Squaloraia*. It was remarked that as the drift must have been transported from some distance, delicate organisms could scarcely be expected, but, notwithstanding, it contained some most minute fish-jaws and palates, of which the author had, perfect or otherwise, one hundred and thirty examples. These were from the eighth to a quarter of an inch in length, and within this small compass some specimens possessed from thirty to forty teeth. In one palate he had reckoned as many as seventy-four in position, and there were spaces from which sixteen more had disappeared, so that in this tiny specimen there had been ninety teeth.

Of the order Reptilia there were probably eight or nine genera, consisting of detached teeth, scutes, vertebræ, ribs, and articulated bones. Amongst these he had found the flat crushing teeth of *Placodus*, a discovery of interest, for hitherto this reptile had only been found in the Muschelkalk of Germany, a zone of rocks hitherto considered wanting in this country, but which in its fauna was represented by the above reptile.

But by far the most important remains in this deposit were indications of the existence of Triassic mammalia. Two little teeth of the *Microlestes* had some years before been discovered in Germany, and were the only traces of this high order in beds older than the Stonesfield Slate. The author's minute researches had brought to light fifteen molar teeth, either identical with, or nearly allied to, the *Microlestes*, and also five incisor teeth, evidently belonging to more than one species. A very small double-fanged tooth, not unlike the oolitic *Spalacotherium*, proved the presence of another genus, and a fragment of a tooth, consisting of a single fang, with a small part of the crown attached, a third genus, larger in size than the Microlestes. Three vertebræ belonging to an animal smaller than any existing mammal had also been found. The author inferred that if twenty-five teeth and vertebræ, belonging to three or four genera of mammalia, were to be found within the space occupied by three cubic yards of earth, that portion of the globe which was then dry land, and whence the material was in part derived, was probably inhabited at that

early period by many genera of mammalia, and would serve to encourage a hope that the remains of that class might yet be found in beds of even more remote age.

A discussion followed, in which Sir Charles Lyell, Professor Sedgwick, Dr. H. Falconer, and others took part, in which the importance attaching to the author's discoveries was recognized.

NOTES AND QUERIES.

Mongrel Words.—Sir,—In some late numbers of the "Geologist" you did good service by pointing out inaccuracies of spelling and speaking technicalities. Would you give the weight of your authority against such a mongrel word as "lignograph," which, half Greek and half Latin, is not to be compared in simplicity or force to the good old English word "woodcut?"—Yours, &c., Critic.

We agree with our correspondent, although we have ourselves used the term "lignograph," in condemning mongrel-words; but "woodcut" is *not* as expressive as "lignograph." Woodcut may be wood hacked, and the merit does not entirely lie with the engraver, who is often only a mere machine, but usually with the draughtsman. We have no objection to introduce the term "xylograph," for "graph" has a broader sense than "cut," if we should make up our mind that "lignograph" ought now to be abandoned. Graph, from *graphos*, too, can not be restricted to a mere drawing or writing, it originally described real incisions—inscriptions such as the Egyptian hieroglyphics—and what we really want is a word to express an illustration drawn and incised on wood.

Assuredly the word lignograph is a barbarism compounded half of Latin and half of Greek, and we have no respect for it; but as it has got into use, is it worth while to change it? If any one adopts the Greek compound we have suggested, we shall be happy to follow the example.

Drift of Norfolk.—Dear Sir,—In my communication to your magazine I have mis-written Tellina Bathica for Tellina Balthica (see page 141, lines 31 and 34); that is my mistake. In the same page, and in the third paragraph, there is an omission which obscures the meaning of the author; in the third line, after "embedded in it," the following should be the reading:—"The layers of shingle are composed of very small pebbles of primitive metamorphic and palæozoic rocks, enclosing an abundance of small fragments of tertiary shells." Will you have the goodness to notice these errors in the next number.—Yours faithfully, C. B. Rose, Swaffham.

Geology of Sligo.—Sir,—As I intend visiting the county of Sligo, would you have the kindness, through the medium of the "Geologist," to state the geology of the county, but more particularly that immediately surrounding the towns of Boyle and Sligo.—J. B. B.

Sligo county consists of an extensive outspread of the Mountain-limestone (or Carboniferous limestone lying beneath the Coal-measures), with some patches of Millstone-grit, and a wide band of Devonian and Old Red Sandstone and conglomerate, passing from Lough Gill to Castlebar, with a granitic nucleus or axis. Near Sligo the upper part of the carboniferous limestone abounds. Near Boyle the Upper Limestone, and some strata of "Yellow Sandstone" of the Devonian series, occur. J. B. B. should consult Griffith's Geological Map of Ireland, either the large sheets or the small map.

Catalogues of Fossils.—Sir,—I should esteem it a favour if you could give me some plan to assist me in making a catalogue of my little collection of fossils. I enclose a specimen leaf of the book I have had made for it, with my idea of the way to do it, and shall be extremely obliged for your opinion, and also for any information you can give me as to where I could find information about those fossils of which I may perhaps have only the names, and whether such a thing is to be had as a catalogue of fossils of the different formations classified.

Deposit.	No.	Name.	Kingdom.	Class.	Family.	Locality.
	1		Invertebrata.	Crustacea.		Bohemia.
	2	Ellipsocephalus Hoffii.	Invertebrata.	Crustacea.	Ellipsocephalus.	Bohemia.

—Yours truly, A. M.

It is not usually found advisable to be continually stating the kingdom and class of animals fossilized, as the student soon becomes acquainted with these great features. A general table of the classification of animals and plants should be kept at hand for reference until the mind is acquainted with the chief points. We should advise a more condensed method, such as the following:—

No.	Genus.	Species.	Stratum.	Rock Series.	Locality.
2	Ellipsocephalus.	Hoffii.	Limestone.	Upper Silurian.	Bohemia.

Catalogue-making for a collection is not an easy task to begin with, and as specimens are always accumulating, the catalogue is constantly requiring alteration. We are not, therefore, prepared to propose any definite plan, but we willingly give our correspondent and our readers some hints which we think may be useful to them. In the first place they must decide upon what *principle* they will base their catalogue. It must be either upon the *stratigraphical succession of the geological formations* or on a *natural history* basis; we must arrange our fossils in stratal groups, each group being the contents of a certain bed or formation, or we must arrange our fossils according to their structure, value, and position in the animal or vegetable kingdoms. In other words, we must sort them into geological or palæontological order. For our part we think local collectors will do most wisely in arranging their fossils with the most minute accuracy and precision in sets representing *each individual stratum* of the formations which are developed in their neighbourhoods. This method will give a real value to the collection, however small, and will also induce the collector to observe minutely the zones of organized forms as they occur in the rock-masses. In the arrangement of these distinct stratigraphical groups the natural history order may be subordinately adopted, and we shall thus get the advantage of seeing at a glance the relative number of species of each animal or vegetable family or order of which any remains exist in the bed. We think also it would be very desirable to head the chief divisions of the catalogue with one or more accurate sections of the formations from which the fossils are obtained, and to number and name the strata of which the groups of fossils represent the organic contents.

The greatest difficulty in cataloguing arises from the constant accumulation of specimens, and the only way to surmount this obstacle, perhaps, is to give a definite number to the species, and a second or subsidiary number to the specimen, thus:—

Catalogue. No.	Specimen. No.	
39	1	Plagiostoma spinosa, Chalk, (Dover). (or Spondylus spinosus.)
—	2	———— ————, Chalk, (Lewes).

To avoid the repetition of the names of great groups, such as Invertebrata of classes, such as Crustacea, the catalogue should be divided by special headings, thus:—

CRETACEOUS FORMATION.

INVERTEBRATA.

Catalogue. No.	Specimen. No.	CRUSTACEA. *Family—Anomura.* Genus.	Species.	Stratum.	Locality.
73	1	Notopocorystes.	Bechei.	Gault.	Folkestone.
—	2	———	———	——	Cambridge.
74	1	———	Broderipii.	——	Ringmer.
75	1	Etyus (?).	Martini.	——	Maidstone.

In answer to the second question, there is no classified stratigraphical list of British fossils. Professor Morris begun such a catalogue in the first volume of this magazine, but when he will continue and complete it *we* cannot say. Professor Morris's "Catalogue of British Fossils," which is arranged on a natural history basis, is a well-known book of reference. Its cost is, we believe, twelve shillings.

One word we must add, addressed to all collectors. Pray label every specimen with the *locality* in which it was found, either by a gummed ticket or by writing on it with ink or India-ink.

Jewstone and Lapis Lazuli.—Dear Sir,—I enclose you an opinion in support of my own assertion that basalt is locally called jewstone. You will find it in a paper on the Iron Kings, by my friend Mr. John Randall, of Madeley. The following is the passage referred to:—

"Decidedly the most singular, if not the most interesting member of the Shropshire field, is the outlier of the Brown Clee hills, more particularly by that of Abdon Barf. It is the highest coal-field in England, being nearly three hundred feet above the summit of the Wrekin, an elevation to which it has been raised by volcanic action, the boiling up of melted basalt, which lifted the entire group. In many places the subterranean and submarine lava has pierced the seams, consuming the coal, calcining the ironstone, and spreading itself in a sheet along the surface. These coveted minerals, by means of little square shafts, well planked on the four sides to the bottom, are sought for amid rents the earthquake and volcano have made, and beneath a covering of basalt so hard as to resist the tool, and from that circumstance called jewstone by the miners."

I ought to have given the real derivation of the word, which is, of course, from the Celtic *dhu* (black). In this border country we have many primitive words. *Clee* is but the Saxon *leagh* aspirated in the Cwyric fashion, as if it was spelt *cllec.*

I have been into the region of the clees this last week, and am very much pleased to acknowledge my entire belief in the discovery of the lapis lazuli, which I noted in my "Rocks," p. 38, as a stated but somewhat dubious production of the Titterstone basalt. While at Cleobury I met with the stone-breaker, William Gettings by name, who found it while breaking basalt for road-stone, and I am quite convinced, from the simple truthful manner in which he related the circumstance, that it was a *bona fide* find.—G. E. Roberts.

Fish and Entomostraca in Upper Coal-Measures.—Dear Sir,—I should be glad to ask in your magazine if any fish-remains have been detected in the estuarine shales of the uppermost coal-measures. (Siluria, third edition, p. 322.) Since I wrote my "Rocks of Worcestershire," this interesting bed has been broken into at a fresh place, Rees' Pit, near Blake-

moor, Wyre Forest (this latter place is described at p. 136 of my book), and I find upon the surface of the top layer of cream-coloured limestone numerous teeth and fin-spines of small predatory fishes, very tiny, scarcely larger than dots and specks till a lens is brought to bear upon them; but upon some parts of this surface they are plentifully sprinkled, and have quite a pleasing appearance, their shining black contrasting so decidedly with the cream-coloured rock on which they lie. Iron-pyrites in very small cubic crystals accompany them. Scales of these small fish are also contained in the limestone, and it has Spirorbis in plenty. The Cyprides are nearly confined to the coffee-coloured shales lying beneath the harder band.

This limestone occurs at the Gibhouse pits and at Blakemoor, but lacustrine bivalve shells (Cyclas) are there its only fossils.—Yours very truly, GEORGE E. ROBERTS, Kidderminster.

REVIEW.

Geological Gossip; or, Stray Chapters on Earth and Ocean. By PROFESSOR D. T. ANSTED. London: Routledge and Co., 1860.

Very pleasant and useful geological gossip Professor Ansted has laid before the world in the eighteen chapters of which this popularly written little book consists. The chapters generally appear to us to be very concise and lucid epitomes of various valuable contributions to geological and physical science. Thus various useful geological matters which are contained in the two short but excellent chapters on the Atlantic seem to have been judiciously selected from that ponderous volume of valuable investigations and data "Maury's Sailing Directions," and from the Reports of the soundings in the Atlantic for the electric telegraph. Dr. Livingstone's researches in Africa, Mallet and Perrey's Earthquake Statistics, Sir Charles Lyell's demolishing attack on the Crater of Elevation theory, Darwin's investigations on the Origin of Species. Mr. Horner's borings into the stratified deposits of the Nile, Boucher de Perthes' Antiquités Antediluviennes, Mr. Prestwich's Paper before the Royal Society on the Discoveries of Fossil Works of Man, Delesse's Experiments on the Metamorphism of Rocks, and other similar labours condensed with admirable brevity, have furnished the chief materials for the really interesting chapters on the Interior of Africa, the Statistics of Earthquakes, the Origin of Volcanos, the Battle of Life, the Antiquity of the Human Race in Egypt, Human Remains in Caverns and Gravel, and the Origin of Rocks and Metamorphism.

If by these remarks we should seem to be detracting from the originality of this work—a merit Professor Ansted, by the total absence of preface or introduction, does not himself seem desirous of claiming for it—we would in conclusion express our sincere wish that the future may be rich in similar periodical epitomes of important scientific labours and investigations as reliably, readably, and usefully set forth, and as admirably adapted for giving the general reader a just view of their leading principles.

THE GEOLOGIST.

SEPTEMBER, 1860.

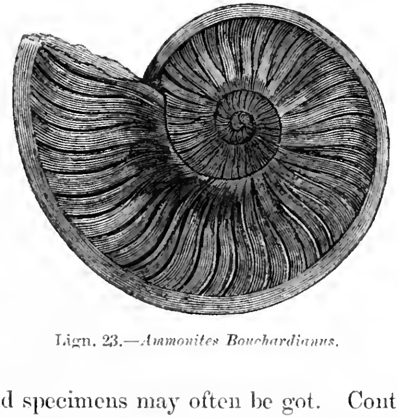
GEOLOGICAL LOCALITIES.—No. I.

FOLKESTONE.

By S. J. Mackie, F.G.S., F.S.A.

(Continued from page 284.)

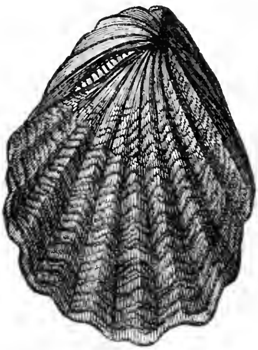
Crossing the railway to the harbour, a footpath brings us to some old white-washed cottages, "The Folly Houses," as they are called (but why I know not), where a young dealer (Griffiths) lives, of



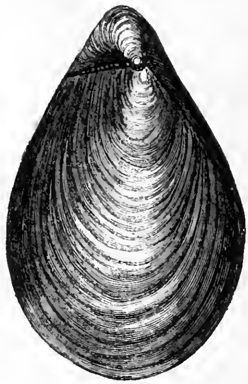
Lign. 23.—*Ammonites Bouchardianus.*

whom some good specimens may often be got. Continuing the footpath to the edge of the cliff, we descend by rugged green-sand steps again to the favourite collecting ground, Eastwear Bay.

Slowly the bright green tide is quitting the flat shore, and leaving again exposed the dark blue clay, dotted with black phosphatic nodes and glittering iridescent shells, washed clean and bright. Daily may you pick up hundreds of these ancient inhabitants of the sea; gather the crop as clean as you will, there will be another harvest for you when the next tide falls. Here are Inocerami, or "fibre-shells," in abundance. Two species, the *Inoceramus sulcatus* and

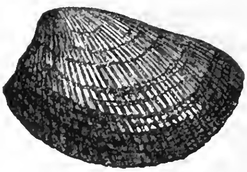


Lign. 24.—*Inoceramus sulcatus.*

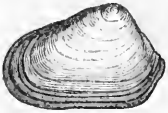


Lign. 25.—*Inoceramus concentricus.*

Inoceramus concentricus—the furrowed and concentric are particularly characteristic of the gault. There is a third and rarer species, *I. Coquandi*, which is also found in the dark-coloured upper green-sand a short distance beyond, towards the old gun-brig "The Pelter," The individuals of these species, so remarkably abundant in the gault, rarely attain to the size of a few inches in length, while other



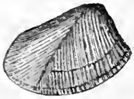
Lign. 26.—*Nucula pectinata.*



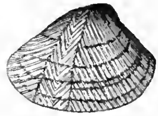
Lign. 27.—*Nucula ovata.*

species of "fibre-shells" of the subsequent era of the chalk attained dimensions of more than a yard in diameter, with shells, however, singularly thin for such large molluscs living in a sea conspicuous for

its immense calcareous deposits. *Nucula pectinata* and *Nucula ovata* are also common and characteristic bivalves of the gault.

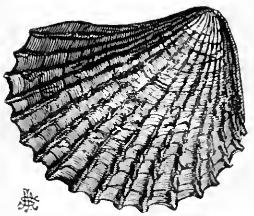


Lign. 28.—*Nucula bivirgata.*

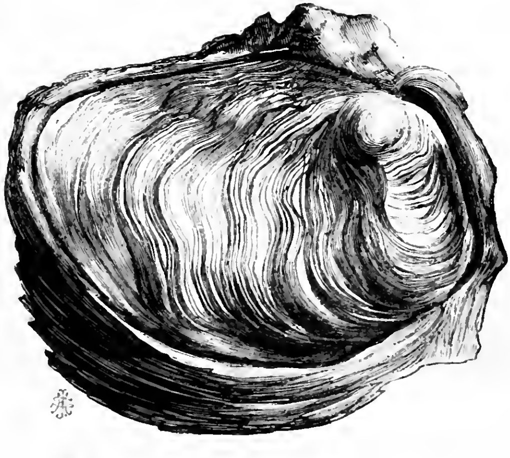


Lign. 29.—*Nucula ornatissima.*

And of the genus Nucula we figure also two other species, which are occasionally to be found, which, from their peculiar and beautiful ornamentation, can be readily determined.



Lign. 30.—*Plicatula pectenoides.*

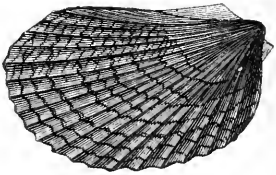


Lign. 31.—*Ostrea Rauliniana.*

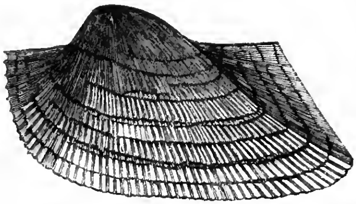
Amongst the other bivalves which the collector is likely to include

in his first gathering, are the readily distinguishable *Plicatula pectenoides* and *Ostrea Rauliniana*.

He will also meet with one or two other species of Plicatula and Oysters.



Lign. 32.—*Lima parallela.*



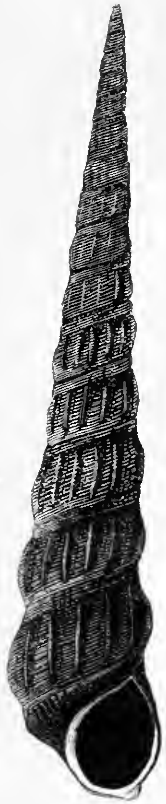
Lign. 33.—*Arca carinata.*

The species of univalve shells of the Gault are few, although of two or three species the individuals are numerically abundant. Very

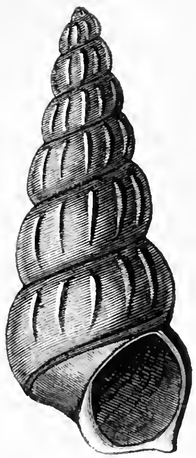
Lign. 34.—*Turritella vibrayeana.*

rarely a delicate Turritella *(T. Vibrayeana*, or *T. Hugardiana)* may be seen on the face of a newly cleaved block, and now and then a

graceful *Scalaria Clementina*, or a handsome *Scalaria Dupiniana* may be exhumed in the same lucky manner. Of the genus Scalaria four or five other species are recorded as occuring in continental localities; of these I believe I have found fragments of the following



Lign. 35.—*Scalaria clementina.*



Lign. 36.—Cast of *Scalaria Dupiniana*, with restored outline of mouth.

at Folkestone—*S. gaultina*, *S. Rauliniana*, *S. gastina*, but I can not speak with certainty.

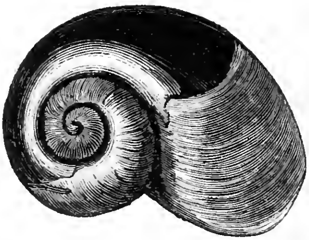
These forms should therefore be looked for by collectors, as should also a little Rissoa, a genus familiar most likely to some of our readers, from the immense abundance of a living species in the pools of sea-side marshes.

The pretty small univalves *Acteon Vibrayeana* and *Avellana* (*Ringinella*) *Clementina* may frequently be obtained in a very perfect state. Two other species of Avellana are recorded from the gault, *Avellana incrassata*, and *A. inflata*.

Lign. 37.—*Acteon vibrayeana.*

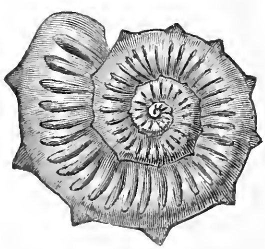
Lign. 38.—*Ringinella clementina.*

The most abundant univalve of the Gault, and which is also one of the characteristic shells, is the *Natica gaultina*, which sometimes also



Lign. 39.—*Natica gaultiana.*

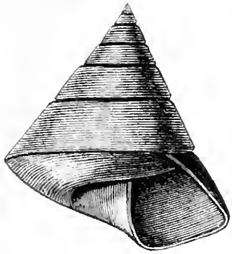
occurs of very large size. Five or six other Naticæ are recorded as Gault species abroad, some of which are likely to be found at



Lign. 40.—*Solarium dentatum.*

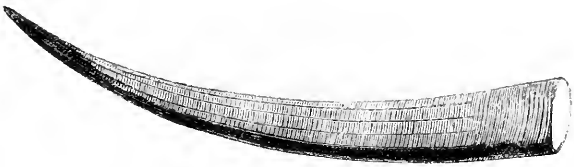
Folkestone, as I have collected fragments of other species, besides the common *N. gaultina.* We have already noticed as being of

common occurrence several species of Solarium, and at page 124 we have figured one, *S. ornatum*. As the two forms, *S. dentatum* and



Lign. 41.—*Solarium conoideum.*

S. conoideum are equally common and characteristic, we think it right to present also their portraits.



Lign. 42.—*Dentalium decussatum.*

The long pipe-like shells of *Dentalium decussatum* will also be found in abundance; and in certain spots, if one is fortunate enough to detect them, clusters of little nautilus-like shells, scarcely larger than

Lign. 43.—*Bellerophina vibrayeana.*

small shot, may be collected. These, the *Bellerophina Vibrayeana*, are not cephalopods, but belong to a lower grade of mollusca, the shell being open throughout, as in the common univalves, and not divided by septa, or chambered, like the Nautilus and Ammonite, for the young of which, from their mere exterior resemblance, they might be at the first glance mistaken by an inexperienced naturalist.

(To be continued.)

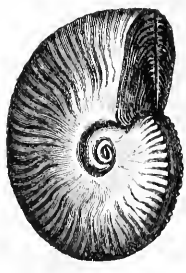
ON AN AMMONITE WITH ITS OPERCULUM IN SITU.

By S. P. Woodward, F.G.S.

Opercula of Ammonites are common in many localities, especially in banks and sections of the Kimmeridge Clay; but they usually occur in broken fragments, and very rarely with their valves paired, unless sheltered within the last whirl of the shell to which they belonged. Even when thus protected the valves are generally displaced, as might be expected if we consider how slight is their union along the suture, and how great were the chances of being shifted by the contraction of the animal after death, by the pressure of external mud.

The British Museum contains several examples of *Ammonites Jason*, *A. Brightii*, *A. fluctuosus*, *A. lingulatus*, and other species with their opercula more or less shifted; and Mr. Charles Moore, of Bath, has several small shells of *Ammonites planorbis* from the Lower Lias, with the opercula remaining in their true position; the smallest individual is only one quarter of an inch in diameter.

I have recently obtained a specimen of *Ammonites subradiatus* (J. Sby.) from Mr. Joseph Wood, an experienced collector (formerly of Bath, but now living at 23, New Union-street, Moorfields), who discovered it in the Inferior Oolite, of Dundry, near Bristol, with the operculum remaining in its natural position as represented in the accompanying figure.



Ammonites subradiatus, with the operculum *in situ*.

The shell measures sixteen lines by twelve and a half, with a maximum thickness of four and a half lines. It agrees with the ordinary run of specimens from Dundry, and differs from the example figured by Sowerby in being less compressed, and more widely umbilicated; the umbilicus measures four lines across, and is bordered by a steep margin.

The operculum is flat in the middle, with a slight furrow along the suture, and is much bent down at the hinder corners where it abuts against the inner whirl of the shell. It is six lines long and four wide, and is sculptured externally with about twelve angular concentric furrows; the inner surface is smooth, as shewn by the fracture and removal of a portion. It closely resembles the opercula of *Ammonites Brightii* and *A. lingulatus*, to which *A. subradiatus* is nearly related.

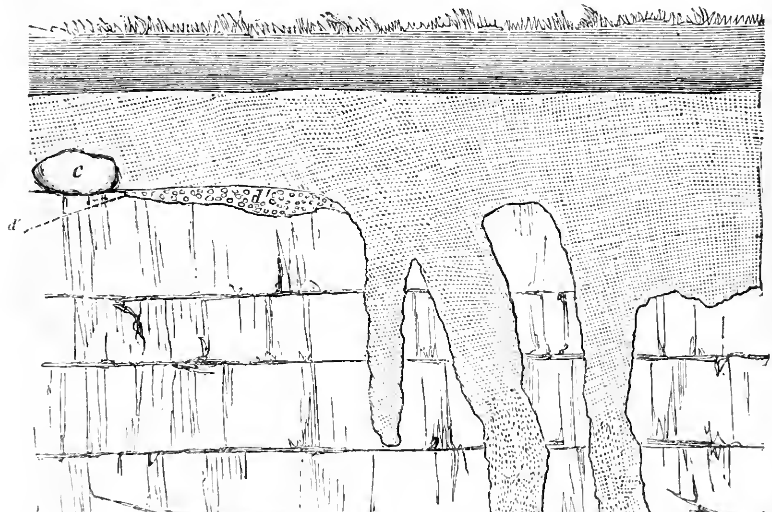
British Museum, August, 1860.

ON THE OCCURRENCE OF "SAND-PIPES" IN THE MAGNESIAN LIMESTONE OF DURHAM.

By J. W. Kirkby.

(Continued from page 298.)

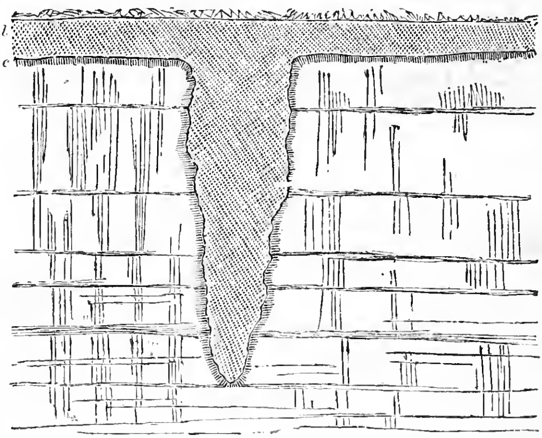
On examining the interior of the pipes, I have invariably found the surface to be more or less decomposed. For about half an inch—sometimes less and sometimes more—the texture and hardness of the i mestone is completely changed—so much so that it is possible to



Lign. 4.—Section of Oblique Sand-pipes on South Side of Quarry.
d, Sand; *d'*, Gravel; *e*, Clay and soil; *c*, Boulder.

scrape it away with the finger-nail. This is the case with all the beds, no matter how they may differ in texture and general character, though some seem more affected than others. This alteration is best seen in those strata that are crystalline. In one part of the quarry

is a bed of which the limestone is hard and dolomitic, and also finely laminated, there being more than a dozen laminæ to the inch; this is its normal character, but where it is penetrated by a pipe it looses its hardness, and becomes dull and earthy; the laminæ also, which in the unaltered portion of the pipe are firmly coherent and difficult to separate, are here easily split open, the surfaces of their planes being highly decomposed; the colour, too, of the decomposed portion is somewhat changed, being of a light yellow, while the limestone of the bed generally is of a brown or grey hue, and so soft has it become where it forms the surface of a pipe that it crumbles to pieces on being touched, and for half an inch in it can be cut with a pocket-



Lign. 5.—*b*, Sand; *c*, Decomposed surface of Limestone.

knife. In fig. 5 the decomposed surface of a pipe is shown for the sake of illustration. When two pipes are very close together, and are only separated from each other by a thin wall, as sometimes occurs, the limestone composing it is affected throughout. The upper surface of the limestone upon which the sand rests has suffered in like manner; and it sometimes happens that a loose piece of limestone rests upon it, and its surface is also just as much decayed, and the same is the case with the surface of the large boulders embedded in the sand when they are of mountain limestone, but boulders of trap are not affected in the least.

Much of the limestone in which the pipes are excavated is crystalline, some of the beds being highly dolomitic. The thickest beds in which they occur have a concretionary structure, exhibiting those peculiar coralloid forms for which the upper member of the magnesian limestone is so famous. On the south side of the quarry,

where the pipes are very numerous, the limestone is more of a slaty nature, though thicker beds of a crystalline and concretionary character are associated. Some of the beds are finely laminated, and a few are soft and marly.

Some of the pipes begin in rubble overlying the solid beds on the south-west of the quarry, and a few small ones about two feet in length are solely excavated in it. The rubble only exists in this region, where the uppermost beds of limestone seem to have been completely broken up, and all signs of their stratification destroyed, by a disturbance of which further traces are still visible in a broken syncline a little beyond the most westerly pipes. The pipes shown

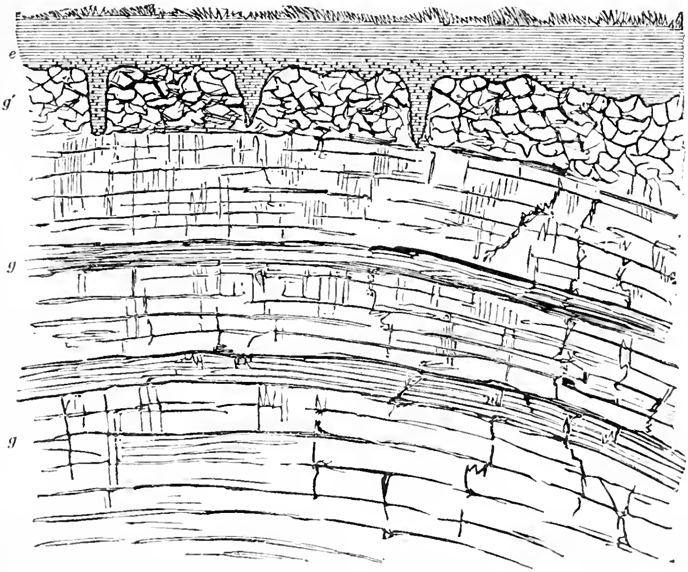


Fig. 6.—Section of Pipes in Rubble, near the Slope of a Syncline.

e, Sand, clay, and soil (the sand thinning out here); *g*, Thin bedded limestone, much fissured and broken to the west; *g′*, rubble.

in fig. 6, which are close to the syncline, are altogether in rubble. The form of the pipes in such loose materials seem to be just as well preserved as when the substance pierced is unbroken.

These are about all the facts that it seems necessary to notice in describing the pipes; and so much has been said on the origin of sand- and gravel-pipes by the various authors who have studied and written on those in the chalk, and being perfectly satisfied that those in the magnesian limestone have been similarly originated, that it is scarcely necessary for me to go far into the question, though it may, perhaps, be necessary to draw attention to the theories broached, and

to state the manner in which the evidence offered by the sand-pipes I have described bear upon them.

There are only two theories that require notice—one being what is commonly termed the mechanical theory, which was strongly advocated by Mr. Trimmer, and the other the chemical theory whose most important supporters are Sir Charles Lyell and Mr. J. Prestwich.

The former doctrine, as propounded by Mr. Trimmer, supposes the pipes to have been formed on coast lines and between tide marks, or at least within the area of broken water, by the action of the surf charged with sand, or assisted by stones and pebbles. He quotes the peculiar wearing of the rocks of our coasts, and maintains that the agency which formed the basin-like and other shallow cavities in these rocks, is the same that excavated the sand- and gravel-pipes of the chalk and other limestones.*

According to the other theory the pipes have been eroded by the chemical action of carbonic acid held in solution by water. Without going into details, it may suffice to state that this theory, as elaborated by Mr. Prestwich, supposes the sand- and gravel-pipes of the chalk to be "extinct natural water-conduits, which the waters at different periods, through incessant filtration from a higher water-bearing stratum in their tendency to reach a lower level, gradually and quietly wore for themselves by their solvent action alone." But it is also the opinion of this geologist that in the harder limestones many of the pipes may have been formed on the sites of pre-existing cracks and fissures.†

Against the former theory there are many grave objections, and in my opinion, it most certainly fails to account for the origin of the sand-pipes in the magnesian limestone. And Sir Charles Lyell and Mr. Prestwich have almost, if not quite, demonstrated its insufficiency to account for the phenomena observed in those in the chalk. It was the opinion of Mr. Trimmer that pipes in the act of formation were to be found in the rocks of modern beaches, but I think with Mr. Prestwich that in this opinion he was mistaken, At least, I know of nothing analogous to them on the Durham coast, and I have conversed with those who have been longer acquainted with it than myself, and who have also examined the sand-pipes, and they are likewise equally ignorant of anything of the kind. Indeed it is incomprehensible how the action of the surf, howsoever assisted or directed, could drill holes so deep and yet so narrow. One objection of great force is that sand- and gravel-pipes are invariably found in calcareous strata. Now how is this to be explained on the supposition of their origin being mechanical? For, supposing this had been the case, why do they not affect all rocks of whatever nature or kind, just as the surf of a littoral region affects rocks of all descriptions, varying its action in degree, and somewhat in mode, as the rocks upon which it acts vary in hardness and general structure? Some

* Quart. Jour. Geo. Soc., vol. viii., p. 273; also vol. xi., p. 62.

† Quart. Jour. Geo. Soc., vol. xi., p. 80.

of the pipes in the magnesian limestone offer another difficulty to this theory; I allude to those occurring in rubble, it scarcely being possible that any mechanical agent, and especially the action of surf, could form tubular or conical pipes, nearly two feet deep and only five or six inches in width, in so loose a substance as rubble. For on such a supposition of their origin, they must of necessity have remained open until completed, so that their walls of loose materials would be unsupported internally, besides being exposed to all the disturbing influences of a littoral region—that is, according to the views of Mr. Trimmer. And it is not to be supposed that these pipes might have been formed prior to the breaking up of the limestone from which the rubble was derived, for any movements sufficiently violent to rend and break up solid beds of limestone, would certainly have destroyed the pipes passing through them.

On the other hand, the chemical theory explains the origin of sandpipes more satisfactorily; and though it is not altogether unobjectionable, yet it suffices to account for their phenomena in a manner that not only seems possible but very probable. Indeed, there is apparently no other agency but a chemical one that could form pipes under the circumstances that seem to have existed while those in the chalk were being formed. It has been shown by Sir Charles Lyell, and also by Mr. Prestwich, that the pipes have been eroded after the alluvium covering the chalk was deposited (this is also evident in the pipes of the magnesian limestone), and that the different strata composing the alluvium have been gradually let down into the cavities of the pipes in the same consecutive order in which they occur where lying undisturbed on the surface of the chalk. In my opinion this seems to oblige the adoption of a chemical origin of some kind for the pipes; for in what other way could they have been formed with the alluvium superimposed upon the surface acted upon? They have also shown that the agent employed did not act upon the flints embedded in the chalk; that the surface of such flints as had been extracted from the matrix in the excavation of the pipes, are not worn in the least; and that when a flint protrudes from the wall of a pipe, neither is it worn or otherwise affected, except in one instance, where the protruding portion was broken off, apparently by pressure, it being found embedded in the core a little lower down. Thus it seems that the agent employed had power only to act upon calcareous substances, and that it was powerless upon such as were siliceous; consequently that it was a chemical agent; for it is not to be supposed had it been mechanical that it would not have left some traces of its action on the flints in the sides and cores of the pipes. But if the reader will refer to the papers of these geologists, he will find full particulars of these facts, and of others of equal interest and importance.*

The softened or decomposed state of the limestone forming the

* Lyell on Sand-pipes, Lon. and Edin. Phil. Mag. 3 ser., vol. xv., p. 257. Prestwich on the Origin of Sand-pipes, Quart. Jour. Geo. Soc., vol. xi., p. 64.

walls of the pipes in the magnesian limestone seems to afford another argument in favour of this theory, for this effect is undoubtedly due to chemical action of some kind; though some may hold that the decomposition of the surface may have resulted after the formation of the pipe by a very different agent; and this is certainly possible, though it must be evident at the same time that whatever decomposed the limestone forming the surface of the pipe, had sufficient power to be the primary cause of their formation; for if the application of the decomposing agent effected the results we see in a certain amount of time, it is not to be doubted that by increasing the period of application, so would we increase its results; so that having here a power competent to originate the phenomena of sand-pipes, it seems more philosophical to credit it with their consummation than to call in the aid of another power whose capabilities even to originate them is almost more than questionable.

But though the chemical theory of the origin of sand- and gravel-pipes is more satisfactory than the mechanical theory of Mr. Trimmer, or than any conceivable theory of a mechanical nature, and though I have little doubt myself but that they have really originated by chemical action of some kind, yet there are one or two points connected with this theory which seem difficult as yet to explain. For instance, it is not easy to understand how the water contained in the stratum overlying the limestone could be so extra-charged with carbonic acid as to possess erosive power enough to excavate the pipes. It seems plain that more than the usual quantity of carbonic acid would be required, or sand-pipes would be of more common occurrence where limestone surfaces are exposed to the reach of rain-water; and if the roots of vegetables supplied the extra quantity, as Sir Charles Lyell suggests, I see no reason why they should not be found where limestones lie immediately beneath the turf, which I believe is never the case in any district where sand-pipes occur. It is possible, however, that rain-water may derive from vegetable matter, as in the case of an overlying morass, an addition to its usual per centage of carbonic acid; and the fact of the remains of so many small roots being found at a depth of three or four feet in the core of clay of some of the pipes I have described, may, perhaps, be considered as rather indicative of something of the kind. It is also possible that it may derive additions from animal remains imbedded in the overlying alluvium, as Mr. Prestwich suggests; and the absence of all remains of this kind in the alluvium in question is no proof to the contrary, for this supposition necessarily includes their destruction in the derivation of their carbonic acid. But still, notwithstanding the possibility of such supplies, I must confess that to me it seems probable that we are still ignorant of the true source of the erosive agent; neither do I see any reason for supposing that carbonic was the only acid employed, and that by it alone were the pipes eroded.

Another difficulty is the special application of the acid or chemical agent to the particular spots occupied by the pipes. If we suppose

water to hold acid in solution, and apply it to a surface capable of being eroded by the acid it contains, we should naturally expect—granting that the water covered the whole surface—that as the hollows were deepened so would the higher portions of the surface be lessened in height, so that as the erosion proceeded the relation of the inequalities to each other would be pretty nearly preserved in their original condition. Mr. Prestwich certainly supposes that in the harder limestone the majority of the pipes are founded on cracks and fissures, though he is of the opinion that those in the chalk have not been thus assisted, but have been worn out of a solid substance. And so far as we may judge from the pipes in the magnesian limestone, which is perhaps harder than any other limestone in which they are known to occur, they certainly seem to bear out the former opinion, for many of them undoubtedly occupy the sites of pre-existing breaks in the strata. But if we grant that any could originate without such assistance, the question still remains unsolved. And that some were not assisted in this way almost seems to be true, and some of those in magnesian limestone appear to belong to this class, so far as my experience goes. However, we must leave the clearing up of this point for future research; at present it seems to be a fact that some pipes, so far as we know, are formed in rocks that are solid and unbroken, and that others exist where cracks or breaks in the strata formerly existed.

These cannot be said to be serious objections to this theory. They are certainly difficulties, but such as a better knowledge of the subject will most probably remove. They do not affect the principle involved so much as its application in questions of detail.

Before concluding I may draw attention to the peculiar position of the stratum of sand beneath which the pipes only occur. By referring again to fig. 1, it will be seen that the sand gradually thins out as it dips, so that the overlying stratum of clay ultimately rests immediately upon the limestone, and so prevents the water lodged in the sand from escaping in the direction which, in its search for the lowest level it would naturally take. It also appears to be as thoroughly enclosed in lateral directions, at least, though its eastern limits have not been reached, it thins out to the west, and is enveloped in the same manner as seen in the transverse section, so that it can scarcely be doubted but that this deposit of sand is overlapped by clay on all sides, except along its upper edge, where it abuts against the gravel. It consequently follows that though it had the power of receiving water collected on the higher grounds, and transmitted to it by the gravel, yet, on account of the impermeable nature of the stratum covering it and overlapping its edges, the water it received would either have to remain lodged in it, or find a lower level by passing through the limestone. Such seems to be exactly the circumstances which Mr. Prestwich supposes to have obtained during the formation of the pipes in the chalk—indeed, which were necessary for their formation. It is interesting to know that there is so close an agreement in the geological relations of the water-bear-

ing strata overlying the pipes both in the chalk and magnesian limestone, for it assists in corroborating the views of Mr. Prestwich.

For a full exposition of the theory I have adopted, I would refer to Mr. Prestwich's most able paper "On the Origin of the Sand- and Gravel-pipes in the Chalk of the London Tertiary District," "Quart. Jour. Geol. Soc.," vol xi., p. 64.

ON THE OLD RED SANDSTONE AND ITS FOSSIL FISH IN FORFARSHIRE.

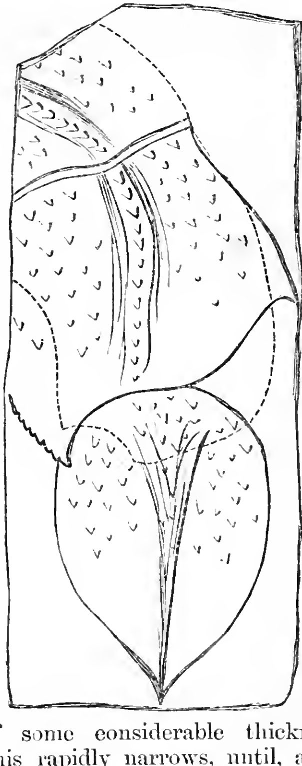
By W. Powrie, Esq.

As anything calculated to throw light on the peculiar fauna of the Old Red Sandstone period must be interesting to geologists, I send you a short notice of some fossils lately found in the flagstones of Forfarshire, which may aid in adding to our knowledge of the peculiarities of the creatures found in these rocks.

Some six weeks ago, by far the finest specimen of *Pterygotus anglicus* yet found was discovered in the "pavement" quarries of Cannyllin: this superb specimen is now in the Arbroath Museum. This fossil, coming clean out from the matrix in which it was imbedded, consists of all the body-segments, a part of the caudal plate being also preserved and well seen in the cast from which the fossil had been lifted. It shows no features absolutely new or hitherto unknown, but it is nevertheless very interesting, as exhibiting the manner in which both the dorsal and ventral portions of this creature had been covered and protected by strong sculptured plates. It also proves that Mr. D. Page was quite correct in the place which he latterly assigned to the curious duck-bill like plate with its wing-like appendages, which, as noticed in Hugh Miller's "Old Red Sandstone," occasioned the name of "Seraphim" to be applied to this fossil. It is found *in situ*, covering the under portions of the segment next the head. In all probability, as suggested by Mr. Page, it formed part of the sexual organs of this creature, and also a covering for the vent or anal opening, there being no vestige of any such opening in either the sub-caudal segment, in the portion of the caudal plate, or telson, preserved, or on the junction of these segments. It gives some idea of the manner in which the different plates forming the body-segment joined into one another, the joinings being seemingly of such a nature as to allow the creature considerable powers of curvature. It also shows its comparative length and breadth, although in this respect it seems to differ from other specimens, showing a rather greater proportional length; but this might have been occasioned by these belonging to different sexes, the one being probably of a more slender form than the other. The head with all its appendages is wanting. The entire length of the fossil,

including the tail-segment, is three feet nine inches, and it measures very nearly twelve inches across at its greatest breadth. Making a fair allowance for the head, the creature must have been over four and a-half feet long, and had thus formed a rather formidable lobster-like animal when swimming in the waters of the primeval world. It had not, however equalled in size the Pterygotus, to which three tail-segments, very recently found in a quarry in this immediate neighbourhood, had belonged, and which are now in my possession.

I here give a rough sketch of this also very interesting fossil. The dotted line marks a portion which lifts clean out from the matrix, leaving a very fine cast of what I consider to have been the dorsal plates of these segments. The upper side of this fossil seems to have formed the upper portion of one of the layers or beds of the rock, and has the sculpturings a good deal obliterated; these are, however, beautifully preserved on the under side, as also on the cast. These markings are much smaller on the caudal than on the other plates, increasing in size, but still small, on the sub-caudal.



Lign. 1.—Hinder Portion of Pterygotus.

The sub-caudal plate, and that anterior to it, have ridges along both the ventral and dorsal surfaces, differing in this from some other specimens of these plates, which only show one ridge. The caudal segment is of some considerable thickness where it joins the one above it; this rapidly narrows, until, after extending to about one-fifth of its length, the upper and lower sides seem to join and become one plate. It would thus appear that the body of the creature had penetrated some little distance into this segment. No appearance of any vent or anal opening is found in these segments; and as, from the state of preservation of this fossil, had such an opening existed, it would have been in all probability readily distinguishable, it affords strong negative evidence against the existence of the vent in this part of the body of the animal. The caudal plate is seven and a-half inches long by five

and a-half inches broad, the sub-caudal about five and a-half inches long by seven and three-quarters inches broad. By comparing this with the Carmyllie specimen, it must have belonged to an animal about six feet in length.

From the same quarry, and about the same time, I was also fortunate enough to procure five very nearly complete segments and part of a sixth of another *Pterygotus anglicus*, the segments of which lift quite out from the matrix, leaving a very thin cast. A seventh segment is also shown in this specimen, lying at nearly right angles to the others; this might, however, have belonged to another animal coming out entire and separate from the other segments. This specimen would seem to have formed part of an animal considerably broader in proportion to its length than the two before described: in this respect it agrees with another very fine specimen now in the museum of the Watt Institution of Dundee, found some two years ago in a quarry on Tealing, consisting of seven of the body segments of the *Pterygotus anglicus*.

These four are by far the most complete remains of this very curious crustacean yet found; besides those of this species, *P. anglicus*, only very fragmentary remains of another species of Pterygotus, *P. punctatus*, have yet been found in Forfarshire. In Cauterland Den, however, and the "fish-beds" near Farnell, several specimens of a Pterygotus very similar in appearance and form to the *P. anglicus* have been discovered, but of a comparatively very small size, being only six to ten inches in length. These have not as yet been examined and named by any competent authority. They are all preserved in the collections of the Rev. Henry Brewster, of Farnell, and the Rev. Hugh Mitchell, of Craig.

After the repeated notices of the Farnell "fish-bed" in the "Geologist," by Mr. Mitchell, it is unnecessary for me to give any lengthened description of this very curious deposit or its peculiar fossils. It was first noticed as affording evidences of being fossiliferous, and pointed out as such by Mr. Brewster. It is, however, to the indefatigable researches of Mr. Mitchell that we are indebted for a knowledge of the curious organisms it contains. It is at present being very fully explored. The Earl of Southesk, on whose estates it is situated, has not only allowed this to be done, but has, with the greatest liberality, furnished labourers for the heavy part of the work, placing the examination of its treasures in the hands of Mr. Brewster and myself; and it is only due to his lordship here to record our grateful thanks for the unexampled facilities it has afforded for having these treasures, so long locked up, made known to the geological world.

Besides a good many specimens of the genera *Acanthodes* and *Brachyacanthus*, discovered and noticed by Mr. Mitchell, several species, apparently new, of *Diplacanthus*, with the remains of other fishes of other genera have already been discovered, as also several curious and seemingly new species, if not genera, of *Eurypteridæ* and other crustaceans. These are in the course of being prepared for

laying before competent authorities for having their affinities determined, and their characteristic markings described.

Mr. Mitchell, in his notice in your July number, rightly places this deposit, as also that of Canterland Den, amongst the very lowermost of our Forfarshire sandstones. The localities as well as the fossils clearly indicate this.

ON THE OUTLIER OF UPPER TERTIARY IRONSAND ON THE NORTH DOWNS OF KENT.

By T. Rupert Jones, Esq., F.G.S., Assistant-Secretary of the Geological Society of London.

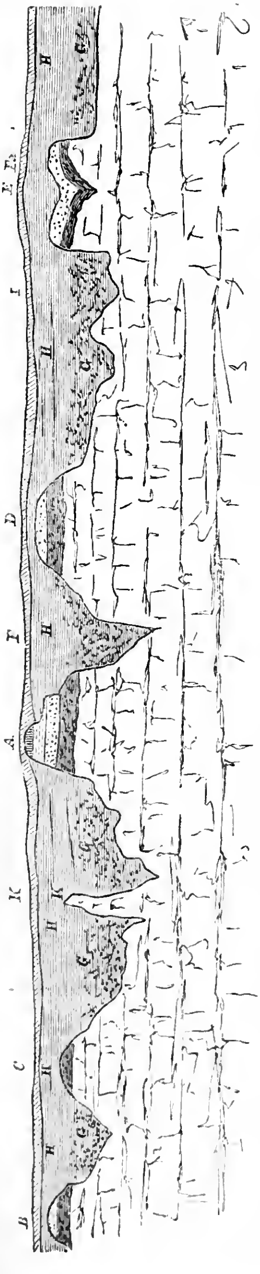
Having at times been asked questions about the "Fossiliferous Ironsands" of the North Downs, which Mr. Prestwich described in the Journal of the Geological Society in 1858, vol. xiv., p. 322, &c., I find that some little diagram appears to be wanted by amateur geologists and general readers for the clearer demonstration of these strata and their relations to the Chalk and the Drift.

I beg, therefore, to offer you the accompanying diagram, illustrative of the relationship of the so-called "Kentish Crag," agreeable, I believe, to Mr. Prestwich's views of the subject, as given in his elaborate paper before mentioned. Having seen the ground at Lenham and Charing, to which Mr. Prestwich refers, and at the latter of which places my friend Mr. W. Harris, F.G.S., had some sections specially made, I feel the greater satisfaction in bearing testimony to Mr. Prestwich's careful working out of the whole question.

In the diagram you will see the whole known succession of these ironsand deposits at A, where such outlines as those of Paddlesworth and Vigo-Hill may be supposed to be represented; and partial remnants are seen at B, C, D, and E. At F and Fa may be discerned instances of sandpipes which have imbibed the ironsands before the changes at the surface led to the denudation of the ironsands off the chalk, and the wearing of the Chalk into furrows and cavities, leaving the clayish sands and gravel now known as "Drift," of which G represents the lower and H the upper portion.

The sandpipes at Lenham, where the ironsand is found to be richly fossiliferous, are such as are seen at F in the diagram, the broken ironstone having sunk gradually in with the sinking superincumbent beds as the cavity was slowly made in the Chalk, probably by the dissolution of the latter by means of percolating water.* At I the

* See Mr. Prestwich's account of the formation of Sandpipes in the Chalk, Journ. Geol. Soc., vol. xi., p. 64.



Lign. 1.—Ideal Section, explanatory of the Drift and "Kentish Crag," on the North Downs of Kent.

Outlier of ironsand, as at Paddlesworth, Vigo Hill, &c.; *C*, Place of Boxer's digging; *F*, Sandpipe, as at Lenham; *I*, Place of trench; *K*, Peak of Chalk projecting into Drift beds.

[Proportions and relations of place and space are not pretended to be observed rigidly or even approximately.]

ironstone is absent, and a thick covering of drift lies on the Chalk; and at such a spot as this Mr. Harris made his large trench, described in Mr. Prestwich's paper (p. 332). His smaller trench was dug at a spot (like that at C H), where a remnant of the ironstone remained under the drift. At H G is a peak of chalk standing high up in the Drift, which may be supposed to be thirty feet thick; such rough pillars of chalk are not uncommonly met with in the excavations which the farmers make in gravel and clay to get chalk for their lands along the back of the North Downs.

Mr. Prestwich truly states that it is difficult to trace at the surface the range of the "Kentish Crag;" and that it is so the diagram will show. It is but seldom that the ironstone and ironsands are well seen at the surface; they are usually masked by the Drift; and further, these are but relics of the original beds; and it is often difficult to distinguish these, even when exposed, from the ferruginous Drift in which they are enveloped.

It is to be hoped that local observers will follow up Mr. Prestwich's researches, and endeavour to work out more particulars about these interesting ironsands; and perhaps the accompanying diagram will serve the purpose of connecting together before the eye the various conditions under which patches of these strata remain on the chalk-surface, and help to direct renewed attention to the subject.

ON CANADIAN CAVERNS.

By George D. Gibb, M.D., M.A., F.G.S., Member of the Canadian Institute.

(*Continued from page* 219).

In the foregoing account it has been my aim and endeavour to describe the geological formations in which the caverns existed; this will be seen at a glance in the following table:—

1	Caverns on shores of Magdalen Islands	New Red Sandstone	
2	Caverns and arched rocks at Perce, Gaspe...	Lower Carboniferous	
5	Little River Caverns, Bay of Chaleur.........	" "	
3	Gothic arched recesses, Gaspe Bay...........	Portage and Chemung groups	Old Red or Devonian
27	Cavern in Bass Island, Lake Erie	Helderberg series	
10	Perforations and Caverns of Michilimacinac	Onondaga Salt group	Upper Silurian
4	The Old Woman, Cape Gaspe	Gaspe limestones	
8	Niagara Caverns	Niagara "	
9	Flower Pot Island, Lake Huron	" "	
25	Mono Cavern	" "	
26	Eramosa Cavern	" "	
28	Subterranean Passages, Manitoulin Island...	" "	
7	Pillar Sandstones, north coast of Gaspe......	Sillery group	Middle Silurian
18	Bigsby's Cavern, Murray Bay	" "	
20	Gibb's Cavern, Montreal	Trenton limestone	Lower Silurian
24	Probable Caverns at Kingston	" "	
29	Murray's Cavern and Subterranean River ...	" "	
6	Arched and Flower Pot Rocks, Mingan	Chazy, Birdseye, and Black River limestones	
21	Probable Caverns at Chatham	Calciferous sandstone	
11	The Pictured Rocks, Lake Superior	Potsdam sandstone	
12	St. Ignatius' Caverns, Lake Superior.........	Sandstone	Huronian Rocks
13	Pilasters of Mammelles, Lake Superior	Greenstone	
14	Thunder Mountain and Pie Island Pilasters, Lake Superior	Greenstone trap	
15	The Steinhauer Cavern, Labrador	Crystalline limestone	Laurentian Rocks
16	Basaltic Caverns of Henley Island	Basalt	
17	Empty Basaltic Dykes of Mecattina	"	
19	Bouchette's Cavern, Kildare....................	Crystalline limestone	
22	Colquhoun's Cavern, Lanark	" "	
23	Quartz Cavern, Leeds	Quartzite	
30	Probable Caverns Iron Island, Lake Nipissing	Crystalline limestone	

Taking the two classes together as representing thirty distinct series of cavernous localities, one is found in the New Red Sandstone formation, two in the Carboniferous, two in the Devonian or Old Red, seven in the limestones of the Upper, two in those of the Middle, and six in those of the Lower Silurian formation, three in the Huronian rocks of Sir William Logan, and seven in the Laurentian rocks of the same geologist. In the last of these they are present in the interstratified bands of crystalline limestone, characteristic of this formation in Canada.

With a few exceptions nearly all occur in limestone rocks, and their origin has depended upon various causes. The first fourteen, which compose the first division, enumerated in a previous part of this paper, are the results of aqueous action, as their situation, present condition, and general description clearly prove. Perhaps an exception might be taken to the formation of pilasters and gothic arched recesses, which are more properly attributable to atmospheric influences. Volcanic agency has given origin to the basaltic dykes of Mecattina (17), the basalt of Henley Island (16), Bouchette's (19), and Gibb's (20) caverns. The same cause has most likely influenced the subterraneous passages of Manitoulin (28), and Murray's Cavern (29). On the other hand, Bigsby's Cavern (18), Colquhoun's (22), the Mono and Eramosa (25 and 26), and Bass Island's Caverns (27) were formed by some other agency, in which a slow disintegration of the rocks has occurred from chemical and other causes, and the soluble particles have been removed by the influence of water, entering by percolation from above, or between the neighbouring layers of rock. The origin of the Quartz Cavern, by the explosion of a pyritous vein (23), is clear enough.

It would be premature to enter at further length into the consideration of the formation of these caverns until further evidence has been obtained. It is hoped, however, that this first attempt to embody a descriptive and connected account of the caverns of Canada in a single paper will be productive of ultimate good results to science, by stimulating the zeal of those on the spot to carry out by further exploration an earnest investigation of this interesting subject, for there is still much to be done to render it complete. Many of the caverns are systematically noticed and described for the first time; and before this memoir was written, the inhabitants of that country were hardly aware that any caverns existed at all, except the comparatively few residing in the immediate neighbourhood of their presence.

ON THE OSSIFEROUS CAVERNS AT ORESTON.

By Henry C. Hodge.

(*Continued from page* 30, *vol.* iii.)

To the thick-skinned quadrupeds belong animals of at least four genera—Elephant, Rhinoceros, Horse, and Hog.

In addition to the large grinders of the mammoth, before described, there occurred a remarkable molar tooth of a very young mammoth (length or antero-posterior diameter of the crown one inch and three-quarters, breadth one inch and one-eighth), containing six plates; it appears to belong to the "thick-plated" variety, but is unlike any of the numerous small grinders of this animal, contained in the British Museum and elsewhere, with which it has been carefully compared.

The larger molars of the rhinoceros were all fragmentary; but a small tooth, having its enamel equally thick with that of the larger specimens, may, it is presumed, belong to a small species of that animal.

The teeth of the horse were comparatively very numerous, and comprised the two species, *Equus fossilis* and *E. plicidens*. Some of the molars were remarkable, not merely with reference to their large size, but also on account of the elegant plications of their enamel folds, the festoons being more complex than usual, and in one of these the presence of a small additional and nearly oval island of enamel is apparent. Whether this specimen belonged to the ancient primigenial Hippotherium I am as yet unable to determine. There were also various specimens of astragalus, a large coronary bone, and portions of jaw with teeth. Other remains included teeth referable to those of a fossil ass or zebra.

The chief remains of the hog were the interesting skull before alluded to; it, however, wanted that portion containing the incisors, tusks, and pre-molar teeth. An interesting fragment, containing three pre-molars *in situ*, and still retaining the base of a tusk of the lower jaw, together with a considerable portion of the extremity of a tusk of the upper jaw was afterwards met with in the stalagmite. Another portion of the jaw of a young hog, its last molar tooth not having yet cut the gum, was found, together with various large molars, pre-molars, incisors, and two tolerably perfect tusks, belonging respectively to the upper and lower jaw of this animal. It was remarked that some of the teeth were in both caverns singularly stained of a yellow colour.

The ruminants probably included one or two species of elk or deer, and two or three animals allied to the ox. Teeth of the sheep or goat were also brought me from the clay, but I have reason to be doubtful about the genuineness of many of the last-named specimens.

Among the remains of animals of the deer tribe, I would specially mention an interesting fragment of jaw, containing several teeth, developed by me with some pains from a large and nearly solid mass of stalagmitic matter, containing various other imbedded bones. There occurred, too, a very few fractured specimens of teeth, suggestive of those of a giraffe (this possibility having been ascertained by comparison with figures of fossil teeth contained in a paper by

Dr. Falconer and Capt. Cautley, in the Proceedings of the Geological Society of London) and a small horn core may, it is presumed, also indicate the presence of an animal allied to a species of this interesting quadruped.*

Among the bones of large oxen were teeth, some characteristic fragments of the metacarpal and metatarsal bones, and two or three specimens of astragalus.

Of the carnivorous animals, canines and molar teeth of the bear predominated, indicating the existence of two or more species, among which may doubtless be included *Ursus spelæus* and *U. priscus.*

The interesting though fragmentary canines of the cave lion or tiger, and of the still larger and probably undescribed species before referred to, were for the most part met with very near to the large grinders of the mammoth before described. Among the specimens referred to the wolf or large dog were many of different magnitude, and I suspect that there may be good evidence of the existence of carnivora intermediate in size between that of the wolf and the larger feline animals.

Of the gnawing animals there were evident traces of small incisor teeth of a quadruped about the size of a mouse diffused through some of the upper parts of the clay, and one tolerably perfect ramus of a jaw was found loosely attached to the side of a small cavity laid open on breaking a large mass of stalagmite.

There also occurred a very few hollow conical teeth of two kinds, some of which are possibly those of very immense reptiles, a cast in the stalagmite of the abdominal rings and elytra of a supposed coleopterous insect, some bones of birds, and, indeed, many other specimens, some of which may still be included in masses of clayey stalagmitic matter that I have not yet had time to examine.

In concluding this portion of my paper I beg to say that I should not have presumed to attempt this necessarily hasty and imperfect description of the fossils so lately met with, but that I hoped it might be of interest, and at the same time give me an opportunity of gaining from competent authorities further information respecting specimens, some of which it appeared not unlikely belonged to undescribed species of animals. It is right, moreover, in this place for me to say that I have been informed by the manager of the quarry that a great number of bones and teeth were discovered before my arrival in Plymouth, and that most of these were sold to the bone merchant. Many also of the remains have been unavoidably dispersed in various other directions during my conduct of these investigations.

In beds of limestone existing further to the east of those in which the just now mentioned fossil bones occurred, and which are evidently a continuation of the same series of rocks, little or no dolomite is included; they are also particularly free from caverns and generally from stalactitic deposits, presenting us with similar limestone rocks, for the most part unaltered by those changes which produce the phenomena of dolomization and caverns. These rocks are coloured black by the oxides of iron and manganese, and are traversed by numerous white calcareous veins; they form a part of the black marble so frequently employed for statuary purposes in this part of England. Distinct bluish black slate and argillaceous hydraulic limestone beds are of very fre-

* Since the above has been written, I have had an opportunity of comparing these fragments with teeth of similar form, from the Sewalik hills, in the north of India, contained in the Museum of Marischal College, Aberdeen; and I am indebted to the kindness of Professor Owen for further confirmation of the opinion that the teeth are really those of a species of fossil giraffe. The Museum at Aberdeen contains numerous other fossils and casts of jaws with teeth, from the same locality. From an inspection of these, I feel also justified in concluding that two other pre-molars found at Oreston belong to a species of fossil camel. These facts will, if fully confirmed, place on record the (I believe) first instance of remains of these interesting genera having been found in Britain, and also tend to indicate their extensive geographical range during the geological period under consideration.

quent occurrence in them, the beds containing occasionally iron pyrites, which, by the action of the weather, tinge the surfaces of the argillaceous and calcareous rocks of a rusty yellow colour. Applying now the above facts to account for the alteration of our cavern-containing rocks, we may legitimately suppose that their previously contained pyrites might by its decomposition yield a supply of sulphuric acid and sulphate of iron, and that these compounds, reacting upon the limestone in their neighbourhood, would (in presence of the air) finally produce sulphate of lime and peroxide of iron, the disengaged carbonic acid at the same time generated affording the required means for effecting (in presence of moisture) the decomposition of its slaty layers; these in their thus disintegrated condition being afterwards compressed by means of superposed beds of limestone into a compact series of beds identical with those of our quarry, and coloured purple in their slaty seams by the above-mentioned peroxides of iron and manganese. The bicarbonates of magnesia, and also the bicarbonates of iron and manganese, required to produce dolomization being at the same time formed by the action of the carbonic acid upon the masses of limestone, which is found on analysis to contain a sufficiently notable proportion of the necessary ingredients.

But the physical evidence that these limestone beds are truly rocks of the black marble series, altered by chemical changes in them, allied to those now pointed out, does not alone rest on the similarity of their strata, allowance being made for the effects of such changes; the hollow cavities of the black marble are occasionally lined with acute scaline dodecahedrons of calcareous spar, and in the supposed altered series of rocks similar crystals are met with, these being generally coroded on their surface, and thus affording an evidence of a change in the conditions existing after their formation. In connection with the deposits of stalactite, and in numerous small cavities in the dolomite, other crystals of calc spar are not unfrequent, but under both these circumstances they exhibit different forms, those of the stalactite being generally acute rhombohedrons, whilst the dolomitic cavities are lined with crystals having the figure of obtuse rhombohedrons, combined occasionally with the plans of a second rhombohedron, which is more acute. There are, moreover, in these altered strata, instances of the formation of a second crop of crystals in the cavities still occupied by the acutely scalenohedral forms, and in all the cases I have had an opportunity of observing them, these secondary crystals invariably contain obtusely rhombohedral surfaces. I may also add that there may be considered to be good evidence that the causes connected with the original formation of dolomite took place under conditions very different from those existing at the present day, for not only does the iron pyrites belong to a very persistent variety of that mineral (no marcasite being mixed with it), but the oxide finally seen to result from its decomposition is not a yellow brown hydrate, like that of the present day, but a red anhydrous peroxide, which would not have been likely, unless the temperature at the time was somewhat elevated.

During the progress of the study of these rocks, I was able to obtain physical evidence of the presence of all the chemical compounds before described as occurring in them, sulphate of lime alone excepted; this, it may be remembered, I supposed to have been removed by the agency of water; and that means adequate for the removal of this somewhat soluble salt existed, was amply proved by the very numerous caverns produced by the decomposition of the dolomite to which so frequent reference has been made. In the lower strata of the quarry the workmen arrived at two very large openings of this kind in the immediate neighbourhood of the bone cavern, and that these communicated with a plentiful supply of water was easily proved by the splashing sound heard when stones were thrown into them.

There remain a few other facts which doubtless have an important bearing on the former condition of the bone caverns.

The stratified beds of the Plymouth limestone dip most generally to the south at about the high angle of forty-five degrees; there are, however, exceptions to this general rule, in certain places the beds exhibiting more or less basin-shaped depressions, caused, we may legitimately presume, by the undermining of their foundation through the decomposition of the before-mentioned irregularly distributed dolomite. If this be true, and similar causes have during former geological periods been in constant operation, the entire strata of this limestone may in their mass have undergone considerable subsidence—a presumption corroborated by the presence on its northern boundary of an older series of unfossiliferous purple and grey slates of immense thickness, having a conforming dip of forty-five degrees, but now seen to lie at a considerably higher elevation. A second inference may also be deduced, viz., that, owing to such causes, the bone caves, at the time they are supposed to have been inhabited by carnivora, might have been situated at a much greater elevation than that at which we now discover them to be, affording these animals a dry and comfortable retreat in the mountain for devouring their prey. The dislocation of these rocks caused by their subsidence would afford, moreover, the necessary mechanical force required to separate in the soft and decomposing slaty layers the limestone beds from one another, affording in this way suitable openings to the animals for entrance to and egress from their caves; the further subsidence again giving rise to displacements of the strata and hermetically closing them, until by still further mechanical change, an entrance being given to calcareous waters, they deposited the stalactite and stalagmite now sometimes found within them. And it may also be deduced from such considerations that even during the human period the opening of these bone caves may have been possible, and that savage races using their dry and capacious chambers as a place of residence, and leaving their easily procurable flint hammers on their exit, they may, through similar chemical and mechanical changes, have once more been closed by the infiltration of stalactitic deposits. With respect, however to this subject, I will not dwell upon it further than to remark that, although we can never bring forward arguments having the conclusiveness of eye-witnesses' testimony against the contemporaneity of man with the extinct mammoth and its congeners, the facts I have stated will, if properly considered, tend to demonstrate that not merely is there no geological evidence whatever to prove their co-existence, but that all the apparently powerful arguments based upon the occurrence of his remains in ossiferous caverns, may be merely deceptive, and of no real significance or certainty whatever, as their presence in them may be easily accounted for through the operation of natural and still existing causes.

Again, there has been observed in the neighbourhood, and at a distance of not more than two miles from the above rocks, the remains of a raised beach on the coast fifteen feet above the present level of the ocean, and traces of others have been met with in various parts of the adjoining district. These raised beaches may at first sight appear incompatible with the view of a general subsidence of the neighbouring strata, but it will, on consideration, be evident that the formation of a large valley, through the falling in of very considerable stratified masses, would naturally produce an upraising at the sides of the depression. In the neighbourhood referred to (that of the Hoe), it may be seen that a great part of the town of Plymouth occupies such a valley, bounded on the south by the limestone hills of the Hoe, and on the north by the high strata of purple slate before referred to. Following out the above idea, and supposing that there has been in past geological time a general sinking of the land in the northern part of our hemisphere, it is not difficult to account for a

colder climate, through much greater elevation and more general distribution of the land, prior to these changes; and it may be easily explained why raised beaches containing shells of arctic type may be compatible with such general depression; and these and other chemical changes acting below the surface of the rocks, and accelerated by the mechanical opening of their fissures through the freezing of water in them, may be reasonably supposed to have in some instances produced sudden floods of water accompanied by fields of ice, accounting for the presence of remains of thick-skinned monsters in the ice and frozen soil of Siberia.

(To be continued.)

NOTES AND QUERIES.

Flint Implements at Hoxne.—Sir,—Last week I paid a second visit to the brickyard at Hoxne, in Suffolk, the interesting locality in which stone axes are said to have been found beneath the remains of extinct animals. In the October of last year I had the gratification of accompanying Messrs. Prestwich, Evans, and Gunn to the same spot.

On my last visit I found the ground as left by the various explorers, and I learnt from the workmen that a clergyman from Norwich (Mr. King) had been there about a month previously, and had found two celts, one was taken from the brickyard four feet from its surface, and the other from the gravelly shingle, which lies between the brickearth and the fluviatile bed, consequently above the latter, and the workmen pointed out to me the precise spots. Mr. Prestwich secured a celt from the brick-earth at his first visit, and Mr. Evans a large portion of a fractured one from the gravel-bed above mentioned. I am not aware that more than four celts have been taken immediately from the beds in which they lie by recent explorers of the ground.

As the object of this communication is to urge the verification of Mr. Freere's statements, which has not at present been done, I will here give his section of the ground, that your readers may more readily understand what I consider is still required to be done to verify it. Not that I in the slightest degree question the faithfulness of his accounts; still, the high interest appertaining to the subject renders it very desirable that no stone should be left unturned to complete the inquiry.

The following is a copy of Mr. Freere's section:—

1. Vegetable earth, one and a half feet.
2. Argill (brick-earth), seven and a half feet.
3. Sand mixed with shells and other marine substances, one foot.
4. A gravelly soil in which the flints are found, generally at the rate of five or six in a square yard, two feet.

In the same stratum are frequently found small fragments of wood, very perfect when first dug up, but which soon decomposes on being exposed to the air; and in the stratum (No. 3) were found some extraordinary bones, particularly a jaw-bone of enormous size of some unknown animal, with the teeth remaining in it.

Mr. Prestwich's section, given in his paper to the Royal Society, agrees with the above as far as the succession of strata; but it is in a correction of stratum No. 3, which is a freshwater deposit, and not a marine—a very excusable error, considering that Mr. Freere's paper was written sixty-three years ago.

From Mr. Freere's communication to the Antiquaries' Society of London, written in 1797, we learn that the flint weapons were taken from No. 4 of the above section, and that the bones of "enormous size" were met with in No. 3, consequently the flints lie beneath the bones, and if so, must have existed at or before the deposit of the bones of the "unknown animal;" and this is the point of interest which requires to be proved. The astragalus of a mammoth in the possession of Mr. Amyott, of Diss, and mentioned by Mr. Prestwich in his paper, I have seen, and there is no doubt respecting its nature; but as Mr. Amyott could not learn from which stratum at the brick-yard it was taken, that bone is of no avail in the inquiry.

There is nothing in the information recently acquired to disprove Mr. Freere's statements; at the same time, sufficient evidence has not been sought to establish them. The probabilities are decidedly in their favour, and the correctness of Mr. Freere's account is greatly confirmed by the fact that the flint-weapons met with in France occur in similar positions, *i. e.*, in association with, and beneath a fluviatile deposit, the flints in both cases being found in undisturbed ground. Nor is our belief in his account weakened, although it appears that all the recent recoveries of the flints have been from strata above the bone-bed No. 3, including the numerous flint-weapons that have been met with by the workmen of late years, those persons having worked the ground for brick-earth above the bone-bed only.

I have before said that this inquiry is of so interesting a nature that it is highly desirable nothing should be omitted which can firmly establish the evidence hitherto produced. As the recent explorations at Hoxne have not extended by digging (for boring only is anything but satisfactory) into stratum No. 4 of Mr. Freere's section, and as all the recently found celts have been met with above the bone-bed No. 3, I hope that some steps will be taken to carry the search thoroughly into No. 4, for till that is done, we are not in a position to confirm or disprove Mr. Freere's interesting and valuable information.

The only trouble, for I will not call it an obstacle, which will occur in the deeper research at Hoxne, will arise from an abundant flow of water; but this may with little difficulty be removed by cutting a narrow trench into the adjoining low-ground—a secondary tributary valley to the Waveney; or by the employment of a common wooden pump.—Yours faithfully, C. B. Rose, Great Yarmouth. August 9th.

Geological Notes on the Punjab.—Dear Sir,—I was going to say there is not a stone of any sort, size, or description in the whole Punjab—at least, in a length of three or four hundred miles that I am well acquainted with, two hundred of which, from Mooltan to Lahore, is the site of the railway. With such a country before me, it is not surprising if an amateur like myself forgets his stone-and-dirt-ology, as I have every prospect of doing. There are, however, some trifling appearances, which the dearth of more important ones forces on the observation; one of these is the "Kunkur," from which all lime is made. I said there were no stones here, I should have said *rocks*, for in various places strewn over the surface of the sandy desert is found a quantity of "kunkur." In some places it is as fine as barley-corns, in others large as eggs, in shape most irregular, mosslike, and eccentric; at times similar to stalagmites, in colour green, brown, and red, fracture conchoidal. The origin of this formation is a subject of interesting speculation. The soil on which it lies is—1, A very fine drift-sand; 2, An excellent brick-sand, or loam; below these, at twenty feet, fine white micaceous sand—say, six to ten feet; then another bed of fine brick-soil and white sand again. This has been the appearance of the soil in the wells bored down in two hundred miles of railway. I made a tour last year to the mountains of Cashmere in search of coal and iron.

I brought down some large blocks of hard "anthracite" and "culm," of which there is a bed about two feet wide, nearly vertical, in fine limestone-shale. I also got iron of a good quality, but Professor Medlicot has condemned both. I can't help it: *I did not put them there.* Coal and iron are also on the Hymalayas; but Mr. Henwood, F.G.S., *condemned them both.* Doctors differ, but in spite of all, the bad coal and bad ore make good iron, and Mr. Sowerby is superintending the erection of extensive iron works on the spot. I know for a fact, which he has mentioned, that in other countries the appearances are not the same as in England, and he who depends only on what he has seen there, is foolish to condemn dissimilar appearances in other countries. In South Africa I have seen iron-beds in gneiss rock, the ore as bright as new-wrought steel; a few miles off the ore quite black and highly polarized; in another, huge blocks of brown oxide, quite hollow, when broken perfectly black and shiny inside, a fine black hæmatite. At the Spring Fontein mines the copper is entirely red like oxide of iron. With such experience, I think it foolish to condemn what does not exactly coincide with our past experience.

When I have time you shall look over the diary of my sojourn in Cashmere. Though it may not be sufficiently scientific to interest you deeply, there may be a few amusing facts to pass half an hour over. I hope to repeat my visit, as I saw some fine fossils in the limestone rocks; but they are so precipitous, even so old and experienced a traveller as I had much trouble to get over them.—Most sincerely yours, JOHN CALVERT, F.G.S.

PLEISTOCENE DEPOSITS NEAR LIVERPOOL.—DEAR SIR,—I take this early opportunity of confirming the observations of your correspondent with regard to the above interesting deposits. In the neighbourhood of Liverpool Pleistocene sands underlie the boulder-clay throughout the district, being seen to advantage on the opposite shore of the Mersey, between Seacomb and Egremont, and are frequently observed in artificial excavations. They contain recent shells, but I am not able yet to prepare a list of them. "False bedding" widely prevails, and in the locality Mr. Darling mentions, a most interesting ripple-marked surface exists just where the sands end, the hollows of the ripples being filled by the superincumbent boulder-clay. At the last meeting of the Liverpool Naturalists' Field Club, I pointed out similar beds of sand beneath the boulder-clay at Hall, ten miles from Liverpool.—Yours truly, GEO. H. MORTON, F.G.S., Liverpool.

MANUFACTURE OF STONE AXES.—SIR,—A market gardener at Redworth, a small village about seven miles north-west of Darlington, dug up a short time ago in his garden a stone hammer. The portion of the garden where it was found has, until very lately, been pasture, and may not have been disturbed for centuries. The axe was found at a depth of three feet from the surface. It is about eleven inches long and four and a-half broad. One end of it is flat or hammer-shaped, and the other is edged; there is also a hole for a handle.

I do not write to you about the mere fact of its being found, but to inquire whether you can give me any information as to the probable method of its manufacture.

The hammer, or axe, is made of basalt, locally called "blue stone," of which there is now a quarry at Bolam, distant about four miles from Redworth. How could so hard a substance as the material of which the great whin-dyke is composed be wrought and bored as this axe has been? Could it be done without using some metal? Though, if metals were known, why manufacture stone implements?

To fashion it by friction would be a work of gigantic labour; and how could the hole for the handle be made?

I must confess myself completely puzzled, and hoping you can enlighten me, I am, Sir, yours most obediently, INQUIRER.

Leaving this interesting inquiry to be fully treated of by some of our correspondents who may have already turned their attention to the subject, we may suggest that the slow process of rubbing stones, first rudely fashioned by fracture, into definite shapes with smooth surfaces by the friction of one piece on another, was probably the actual process of manufacture, however long a time it may have required. The hole may have been produced by the slow grinding of pieces of flint into the stone, possibly by means of some rude revolving apparatus. At all events the manufacture of these hammer-heads must have been extensively carried on throughout the country, especially in the midland and northern countries, whence specimens of almost elaborate workmanship have been not unfrequently obtained.

Mr. Thomas Wright, the eminent antiquary, we know entertains the opinion that the better formed of the antique stone implements were contemporaneous with those of metal, and were made with metal tools.

Geology of Cornwall.—In our reply, page 199, to the inquiry respecting the geology of Cornwall, references to Sir Henry De la Beche's excellent "Report on the Geology of Cornwall, Devon, &c.," and to the Rev. Professor Sedgwick's "Memoir on the Slate Rocks of Cornwall and Devon," in the Journal of the Geological Society, vol. viii., p. 1, were accidentally omitted.

Geology of Reading.—Dear Sir,—I read in the April number of the "Geologist," page 151, in Mr. Charles Rickman's letter, some reference to the geological series of deposits in this neighbourhood. We are referred to the Quarterly Journal of the Geological Society for further information, but I fear it is not in my power to get that; so may I, as a constant subscriber ever since the first issue of your valuable magazine, beg of you to give us a little information occasionally as to the strata and fossil varieties in this neighbourhood. The only one I have found has been a large oyster in the chalk beds of Caversham.

I hope you will excuse my taking this liberty.—Yours much obliged, A. H. Reading.

If we are not favoured by some correspondent with a detailed account of the chalk, Thanet sands, Woolwich beds, London clay, and gravels of the Reading district, we will take an early opportunity of fulfilling our correspondent's request. But we hope that this interesting county will find its own geologist. The neighbouring district of Newbury, consisting of very similar formations to those of Reading, has been described in a little pamphlet by Mr. T. Rupert Jones (Geol. Hist., Newbury, 1854. Blacket, Newbury; Lovejoy, Reading.)

Geology of Sligo.—I see with surprise that you have in last "Geologist," page 317, mistaken the band of mica-schist and other hard old transition rocks which form the Ox mountains in Sligo and Mayo for Old Red Sandstone. The latter is very thin, and but rarely seen in the neighbourhood of Sligo, according to Sir Richard Griffiths.

The limestone of Sligo is peculiar and unlike the great mass of that forming the centre of Ireland; it seems to be a great development of the lower beds resting upon certain others (sandstones) conformably, concerning which there is a difference of opinion, viz., as to whether they are really below the limestone, or are interstratified with it at a considerable height in the formation.

I had hoped to have investigated this point when I was last at home, but was prevented by the weather. Now, however, we may perhaps hope to hear something of the rocks in that country from your correspondent, particularly if he should be connected with the railway which is being made, and will cross both the range of older rocks and that of the Curlew mountains, formed, I believe, in some places of Old Red Sandstone.—Very truly yours, A. B. Wynne.

Hibberti on Fossil Fish of Burdiehouse.—Sir,—Can you inform me

what the price of Dr. Hibberti's work is on the fish-remains discovered at Burdiehouse by him, and if it can be obtained?—I remain yours respectfully, J.W.

This book is out of print, and not to be obtained of the publisher. The original paper is in the Transactions of the Royal Society of Edinburgh.

Extract of a Letter from Edwd. Wood, Esq., F.G.S., Richmond, Yorkshire.—Should any of your numerous readers be about to form a geological museum with plate glass wall-cases on a somewhat extensive scale, I am certain that much trouble and outlay, as well as time, will be saved by having sent to them the elevation and plan of the cases as just completed in my new room. Though the drawings were carefully made, and subjected to the well practiced eyes of the courteous *savans* of the British Museum and the Survey, still the cases had to be pulled down, and altered again and again. No one but he that has tried it can know how difficult it is to stratigraphically arrange a large series of fossils in proper display, or to make large and heavy slabs and microscopic examples fit together to line and to rule. At last this has been in a great measure accomplished here; and I know that any application for the plans addressed to Mr. John Metcalfe, the skilful cabinet-maker of this town, who has so admirably made all the cases, will receive a prompt reply and much disinterested information.

It may likewise be valuable to some to know that Mr. Gavin Young, of Carron Mills, Edinburgh, is a most admirable lapidary; and though a perfect stranger to me, he has been entrusted with many of my rare fossils to reduce and cut; that in about a hundred sent to him, all have been cheaply and immediately done, and that the most ponderous boxes sent have been so wonderfully reduced in weight, that it required an examination to be assured that all had been returned. In every instance the lines marked for cutting have been carefully kept—the value and capability of arrangement of rough specimens wonderfully increased; and that in no instance has the delicate surface of any one specimen been in the slightest degree scratched or injured.

Remarkable Property of Iron.—In the year 1856, says a contemporary, Mr. March, an able chemist connected with the Royal Arsenal, discovered that it was an invariable rule with iron which has remained a considerable time under water, when reduced to small grains or an impalpable powder, to become red hot, and ignite any substances with which it comes in contact. This he found by scraping some corroded metal from a gun, which ignited the paper containing it, and burnt a hole in his pocket. The knowledge of this fact is of immense importance, as it may account for many spontaneous fires and explosions. The tendency of moistened particles of iron to ignite was discovered by the great French chemist, Lemary, as far back as the year 1670.

Silver in California.—M. Peligot, a professor of chemistry in Paris, has recently received a specimen of mineral silver, which reached General Morin, the Director of the Conservatoire des Arts et Metiers, from California. It It is said to have been taken from a mine which occupies a surface of twenty-five square miles, and is of great depth. The mineral is described as remarkably pure and rich, containing not less than twenty-six per cent. of silver, together with a fair proportion of gold, copper, and antimony. Should the mine be as rich as it is described, it will, in the opinion of the learned chemist, restore the equilibrium between the relative value of gold and silver, which was beginning to be disturbed.

Fossil Flint Implements in America.—Sir,—Can you inform me if any truly fossil flint-implements have been found in America? whether the flint arrow-heads, &c., commonly found in Canada, Peru, and other places on the great western continent belong to the historical or geological periods? and whether any weapons similar to those from the English and French gravel drifts have been discovered in America?

These questions have reached us too late to say more than that as yet no very accurate records have been made of the soils in which these instruments have been imbedded in the countries named. Some are undoubtedly of the historic, others may be of the geological period. We may refer our correspondent to vol. i. of the Smithsonian Contributions to Knowledge (Washington, 1848). In this work, in an article on the "Ancient Monuments of the Mississippi Valley," by Messrs. Squier and Davis, there is figured, at p. 211, a spear-head, apparently similar in shape to the specimen found by Mr. Wetherell at Hornsey, and figured in Mr. Mackie's Geological Diagram No. VI. (fig. 7). At page 214 are figured on a very reduced scale three implements, which appear, as far as one can judge of the engravings, to be of like form to the so-called flint "celts," (but which are more probably spear-heads) from the drift. In writing of these, the authors say:—

"It is a singular fact, however, that few weapons of stone or other materials are discovered in sepulchral mounds; most of the remains found with the skeletons are such evidently as were deemed ornamental, or recognised as badges of distinction. Some of the altar or sacrificial mounds, on the other hand, have the deposits within them almost entirely made up of finished arrow- and spear-points, intermixed with masses of the unmanufactured material. From one altar were taken several bushels of finely-worked lance-heads of milky quartz, nearly all of which had been broken up by the action of fire. In another mound an excavation six feet long and four broad disclosed upwards of *six hundred spear-heads, or discs of hornstone, rudely blocked out, and the deposit extended indefinitely on every side.* Some of these are represented in the accompanying engraving. They are necessarily much reduced. The originals are about six inches long and four broad, and weigh not far from two pounds each. Some specimens from this deposit are nearly round, but most are of the shape of those here figured.* We are wholly at a loss respecting their purposes, unless they were designed to be worked into the more elaborate implements to which allusion has been made, and were thus roughly *blocked out* for the greater ease of transportation from the quarries. With these relics were found several large nodules of similar material from which portions had been chipped off, exposing a nucleus, around which the accretion seems to have taken place. These nodules are covered to the depth of half an inch with a calcareo-siliceous deposit, white, and of great hardness. Such nodules are found in the secondary limestone formations. Several localities are known from which the material may have been obtained. One of these, named "Flint Ridge," exists in the counties of Muskingum and Licking, in Ohio. It extends for many miles, and countless pits are to be observed throughout its entire length, from which the stone was taken. These excavations are often ten or fourteen feet deep, and occupy acres in extent. It is possible that the late as well as the more remote races worked these quarries. Like the red pipe-stone of the *Coteau des Prairies*, this locality may have been the resort of numerous tribes —a neutral ground, where the war-hatchet for the time was buried, and all rivalries and animosities forgotten."

This topic is one which we shall follow further out in our intended series of papers on the "First Traces of Man," which we commenced in the "Geologist" in vol. ii., p. 432, and which we intend very shortly to resume.

* Flatly pear-shaped, or more or less pointed.

THE GEOLOGIST.

OCTOBER, 1860.

GEOLOGICAL LOCALITIES.—No. I.

FOLKESTONE.

By S. J. Mackie, F.G.S., F.S.A.

(Continued from page 327.)

Of all the Gault fossils, the Ammonites take precedence both for beauty and number; and, holding as the Cephalopods do the highest rank of molluscous animals, we cannot but view their extraordinary variety in this deposit with singular interest. If, therefore, we dwell here somewhat at length on their general classification, we could scarcely choose a more fitting occasion.

As ordinarily seen in collections, the Gault Ammonites appear to be all more or less of diminutive size. Few exceed two inches in diameter; many are little more than an inch; while one of three inches would be looked upon as a fine individual.

These specimens are, however, for the most part only the central whirls solidified or hardened by interior walls, or in-fillings of iron-pyrites. In the Gault itself Ammonite-shells of far larger size—commonly of six or seven inches across, sometimes more than a foot—are not merely frequent, but extremely abundant, although, from the fragile state of the main mass, they are commonly cleft to pieces in breaking out the central pyritous cores without attracting observation.

Even if collected, their tendency to peel away from the matrix

and to shatter causes them to be soon ejected from the cabinet. This latter case is, however, the rarest, and the large part of the shell is usually passed by and disregarded by collectors, which is to be regretted, as from the adult forms the best information is to be obtained of the structure of the animal, and particularly of the form of the mouth, or orifice, of the shell.

This, well preserved in many specimens from other clay-strata, is a part unknown in many species, even amongst the commonest, from the Gault. Its outline is very distinct from those foliated sutures which mark in the casts of these fossils the septal divisions of the shell; and which are often thought by amateurs, as they have been by some unreflecting naturalists, to represent the successive edges of the mouth at the various stages of growth. Such, however, is not the case. At the mouth, or opening of the shell the actual growth of course took place; it was *there* the shell-matter was added layer by layer to the edge or rim, as we see it done in other shells. But this was effected by the upper part of the Ammonite-animal, while, on the contrary, it was by the *lower* part of the same animal that the foliated septa were formed which divided off the unoccupied portions of the shell into separate chambers. These septa or divisional plates are smoothly concave and plain in the living nautilus, because the *lower* extremity of that animal is simple and bag-like; while in the Ammonite and others of the extinct cephalopods, as the *Hamites,* *Turrilites*, *Goniatites*, &c, it was concave and more or less highly foliated, or zig-zag, as the ovaries on each side were more or less elaborately constructed and sub-divided into small and separate egg-bags.

These foliations are entirely lateral, the central part of the septa being smooth and undulating, while slightly varied striations, a narrow flat band, or a tendency to prismatic colouring on the sides of the shell-substance, may guide the experienced eye of the naturalist to detect the outlines of the former cusps or undulations which ornamented or characterized the mouth of the living shell. But these indications of the former mouth occur solely on the outside of the shell; the foliations, being, in fact, the end-sections of the septa, are seen only in the *casts*, where, to use a familiar simile, they may be compared to the ends of the rafters of the

various floors of a house when the front wall has been completely pulled away.

No one can look at the pearly nautilus shell—the animal itself is very rarely to be seen, even in a preserved state—and the common native cuttle-fish of our shore, without noting at once a marked difference in the characters apparently presented to his view. A comparison of the animals, however, shows equally plainly that they are truly members of the same natural group. So it is not to be wondered at that the early geological investigators should have failed for a long time to have recognized the very various objects now known to have been various solid parts of differently modified cuttle-fish as referable to the class of Cephelopoda. Who, at first sight, without previous training, would have imagined the dart-like sparry Belemnite and the glittering nacreous Ammonite to be the remains of animals belonging to this one group?

The position of the ammonite in the animal kingdom was the more easily made out from its general resemblance to the nautilus, whose pearly shell is a familiar ornament in our rooms; but the translucent spathose Belemnite sorely puzzled the early naturalists. It was amongst the earliest recorded fossils, and some singular notions were entertained of its origin, and some equally singular medicinal properties were also assigned to it. Whether or not belemnites are the objects referred to as the Lyncurium by Theophrastes, or the Dactylus idæus by Pliny, they are certainly noticed by Agricola in 1546.

It is curious to trace the first strange guesses made as to what these objects were, und then to see how slowly, how very slowly, their true nature was made out. Some took them for the tails of crabs, the vertebra of snakes, the teeth of whales, &c., and they were alternately referred to every class of animals from the mammal to the polype; sometimes even they were put with marine algals, and lastly they were thought to be "thunder-stones."

George Agricola, to whom we have already referred, knew the entire Belemnite with its alveolus, and was the first author who used the generic term. Conrad Gesner, in 1565, follows with the first figures of these fossils, and in 1596 we find Célespin occupying himself in attempting to make out their origin, and regarding the

Belemnites, Glossopetra (sharks' teeth), and the thunder-stones as derived from the Pinna or some other marine shell. Passing by Michel Mercati, Boulin, Imperato (who regarded them as stalactites), Schwenkfeldt, Libavius, Boetius de Boot, Ceruto, Chiocco, Aldrovandi, Merret, Charleton, and others, who speculated to little purpose, copied from each other, or blundered, as Olans Worm did, in mistaking them for flints from the chalk, we come to Lachmund, who, in 1669, made a further step towards knowledge by a primitive distinction of species, giving a goodly number of woodcuts, which, though rude in execution compared with our modern skilfulness in that department of art, are sufficiently indicative of the objects.

Our countryman, Lister, though generally so advanced beyond his contemporaries in natural history knowledge, did nothing for the Belemnites. In 1678, we find him placing them immediately after the Echini, or sea-urchins, in his division of Lapides turbinati non spirati without remark.

Grew, Jean Schroeder, Sibbald, Leibnitz, and Jacobæus follow with equally bald results up to the time of Lhwyd, who made a great collection of minerals and fossils from different countries, particularly from England, and in 1699 devoted a chapter to Belemnites, figuring all the varieties in his possession. While regarding the alveolus as the matter which had filled the cavities, he searches little after the origin of these fossils, and contents himself with considering them as concretions made in the tubes of worms.

With the dawn of the eighteenth century a more intelligent ray of knowledge began to beam, although absurd notions still continued to be propagated. Tournefort (1702) persisted in regarding them as mere minerals (lyncurium) to favour his doctrine of the growth of stones, and their reproduction from germs. Ghedini, believing them to be crystals, thought they ought when perfect to have two points instead of one. Helwing, following Lhwyd, looked upon them as either marine plants, stony zoophytes, or marine tubes, and imagined that they were pointed at both ends before they were petrified and formed part of the rock. Volkman (in 1720), speaking of those of Silesia, supposes them to be spines of fish; and even Swedenborg, having only seen the alveoles, regarded them as the

tails of crayfish. At last, however, appeared in 1724 the celebrated dissertation of Ehrhart on the Belemnites of Franconia, in which he demonstrated

1st That they were parts of marine animals allied to the Nautili and Spirulæ; hence he perceived the affinity between the alveolus and the body of the Belemnite.

2nd That they grew or were enlarged by the application of external layers of animal-matter. And

3rdly That their chemical composition was indicative of an organized body.

And these points he rendered more intelligible and evident in his second edition (1727) by a plate of figures.

(To be continued.)

NOTES ON THE METALLIFEROUS SADDLES, OR ORE-BEARING BEDS IN THE CONTORTED STRATA OF THE LOWER CARBONIFEROUS ROCKS OF CERTAIN PARTS OF DERBYSHIRE AND NORTH STAFFORDSHIRE.

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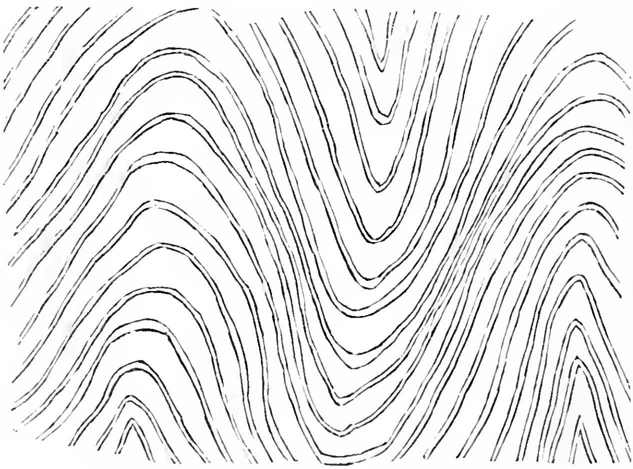
The inferior division of the Carboniferous series in Derbyshire and North Staffordshire, composed of calcareous rocks and shales, and forming the Mountain Limestone group of those counties, presents, particularly about the neighbourhood of Alstonfield, some very interesting and remarkable associations of metallic minerals with certain mechanical disturbances of the strata; moreover, these associations are not to be indiscriminately classed with the general phenomena of the mineral veins of the districts in question, but must be considered as special facts requiring a separate consideration and explanation. Their existence is no new discovery, since they have been recognized from the earliest times that mines have been worked in the places where they occur, and where also they are at most times regarded as valuable features, inasmuch as the richest deposits of ore have been found in connection with them; indeed, so decidedly has this been the case, that, in working the mines, much of the future success has been calculated by the amount of probability of any particular vein intersecting the disturbed beds; such unions

having, in nearly all cases, been attended with most important results, both as respects the quantity, as well as the kind of ore met with. Nevertheless, I am not aware of their having ever received any particular attention from geologists, nor of their having been anywhere described, circumstances which may probably arise from the fact of these beds only being visible below the surface, and usually in deep mines; or they may have remained unnoticed, from the really small amount of scientific observation which in this country has been brought to bear on the facts connected with metalliferous deposits, compared with what has been done, and is still doing, in other branches of physical geology. The present article is drawn from memoranda made during several careful surveys of mines which are notable, in North Staffordshire, for exhibiting the phenomena of the saddles in great force.



Lign. 1.—Contorted or plicated strata seen in vertical section.

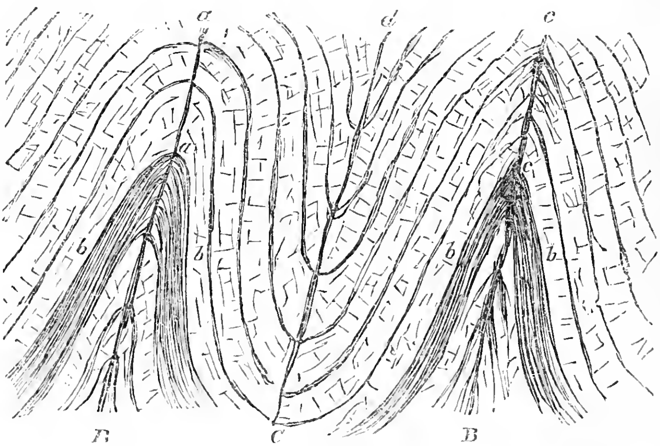
The term metalliferous saddle, or rather simply "saddle," as used by the Derbyshire miner, is a very expressive one, and pictures, almost without the necessity of further description, the particular kind of structure to which it is applied. It will, however, assist us subsequently in more ways than one if we here recall a few of the facts connected with contorted strata so called, and which are so frequently to be observed in various rocks in nature. First then, in many localities, where good cliff-sections are exposed, the strata of various common rocks, and particularly schists and shales, are seen to have been crumpled, so to speak, or in other words, the beds, instead of continuing on with their usual regularity, become twisted and folded into the most singularly complex forms, this kind of structure

being sometimes maintained over a whole country, although generally confined to a comparatively small portion of the strata. It happens that the contortions, which are not to be confounded with those larger effects of the same kind known as synclinal and anticlinal axes, are so complicated that, as in some of the oldest rocks of North Wales, the folds are partly turned over, and the order of the strata is actually inverted; but such extreme cases are comparatively rare. The country where the beds are thus disturbed almost invariably displays other proofs of mechanical alteration, and usually more or less of elevation. As conducting to the explanation of the disturbances which may have taken place in a district these phenomena are often very useful guides, since they nearly always indicate the direction in which the disturbing force was applied, and this I shall presently show.

It may be demonstrated experimentally that plicated or folded strata are the result of great lateral pressure, aided by much superincumbent weight. Sir James Hall—whose important experiments in uniting chemistry with geology laid out a path which, unfortunately for the progress of the latter science, in at least one department, has been since too little followed—succeeded admirably in reproducing the appearances in the rocks by placing plates of moistened clay one over the other, with a heavy weight on the top of them, and then squeezing them at the sides. The effect produced is represented in the diagram (fig. 1), which will also serve as an illustration of the contortions on the large scale, as in nature. The appearances, however, are best imitated by thick paper, or cloth, moistened by gum, or other adhesive liquid, which will cause the sheets to retain the form they may assume, after the pressure is withdrawn. It will be observed that a series of consinuous waved lines are produced; in fact, a miniature succession of anticlinals and synclinals, and it is one of each, taken separately, that the miner calls a saddle (see fig. 2). The crown may be either an unbroken arch (*a*) (fig. 2), or, if the squeezing and bending has been more severe than the rock could stand without fracture, it may be an angle (*e*), more or less acute. From the crown downwards there is usually a well marked fissure, or joint, traversing all the beds in succession with more or less inclination from the vertical (fig. 2. B B′). The sides of a saddle are termed its wings, *b b′* (fig. 2), and the crown is called the huckle (*a*); the joint dividing the crown is called the saddle-joint (*a* B, *e* B′). The space between two saddles at its lower part, which on the large scale would be termed a synclinal axis, is called the trough (*c*) (fig. 2), and. as it is usually fractured like the crown, the dividing fissure is called the trough joint, indicated by the line *d c*

What I have just described relates more particularly to the limestone saddles than to the plicated beds of the calcareous and bituminous shales which overlie the limestone, since in the latter, although the same general structure prevails, there is more confusion in the strata.

The saddle-beds are recurrent through the whole thickness of the limestone series, and, at least, five sets of these beds are distinguished in the neighbourhood of Alstonfield; but, no certainty belongs to this enumeration, inasmuch as the same strata are plicated in certain parts and not in others. The saddle-beds are known to crop out at the surface, and a clue is thereby afforded to and embraced by the miner in searching for them below; but it has been particularly remarked that the contortions are always more gentle above than in depth, resolving themselves, generally, into a long swell very different from the rapid and closely associated folds of the same beds as seen below the surface. In fig. 3 the dotted lines, *x*, *y*, *z*, represent this gradual dying out of the folds of the beds *a a* at their crop *a′ a′*; but I shall have presently occasion to refer again to this curious cir-



Lign. 2.—Contorted beds of alternating limestone and shale strata, showing the formation of "saddles" and "saddle-joints."

cumstance. The breadth of the saddles from wing to wing, taken midway above the trough, of course, varies greatly, but there is something like an average, and which may be stated at forty feet. The joints, both huckle and trough, run very regularly; and it is worthy of remark that they are always continued out of the beds either above or below. Their general direction is north-north-west and south-south-east, which is also the direction of the joints, in a large majority of cases, of the Mountain-limestone, in Derbyshire and Staffordshire. The perpendicularity of the saddles themselves on their line of strike (east and west) is a matter of some importance, since by the way in which they are inclined so may the direction of the maximum compressing force be ascertained: thus if the majority of the saddles bear to the right, it is more than probable that the greatest resistance was to the left, and that the force, whatever it

might have been, continued to act from the right on the lower portion of the already contorted beds.

In the shale beds these rapid contortions do not strike us with so much surprise as when the phenomena is seen in the more massive and coherent beds of limestone; and then it seems scarcely credible, even to the geologist, that the folded strata could ever have been deposited horizontally, and that, with comparatively so little fracture, they could have been bent into their present form by simple pressure. In cases where a separate well marked bed, left standing, forms the roof and sides of a level in a mine, the entrance to such level from a transverse gallery or shaft wears all the appearance of an arch of artificial masonry, and the deception is only removed by close inspection of the contiguous rock. Natural arches, formed by the weathering and removal of the soft beds, are not uncommon in cliff sections of contorted rocks, but then the spread of the strata is usually much wider, and the idea of such vast compressing force having been put in action is not so obtruding. The coal-measure "binds" (argillaceous sandstones) on the shores of Carmarthen Bay between Saundersfoot and Tenby display some very remarkable examples of weathered contorted beds, but they are in no respects equally striking with those of the limestone strata above described.

Next to the form and structure of the saddles we may conveniently consider the associated minerals; but, before we can do this satisfactorily, the circumstances connected with their union with the metallic veins—which invariably, in the districts which now occupy us, form part of the general system of displacements of the stratification—must have our attention; and perhaps it may simplify matters in this respect if we select an example for description. Let us take the case of the Old Ecton mine, in the parish of Alstonfields, North Staffordshire. This mine deserves our choice not only because it has made very large returns of ore, but also because, from the length of time it has been working, the ground has been so thoroughly opened that the relationship between the saddles and veins has been better made out than in more recently opened and less developed setts in that neighbourhood. The veins which here exist are "pipe veins" and "rake veins," and may be thus particularized.

The pipe veins are irregular cavities inclined at angles varying from fifteen to thirty-five degrees to the horizon; have no proper longitudinal bearing, like the Cornish lodes for instance; and have generally the most important of their expansions parallel to the bedding of the strata which they traverse; and whose dip is also the direction of the pipes, although these are by no means always confined to any distinct bed of stone, but, on the contrary, usually pass through several beds in succession until they reach the saddles. The general relations of a pipe vein to the stratification of the rocks is shown in fig. 3, *E E*, which also represents the course of such a vein through the different beds in the direction of their dip, as just mentioned.

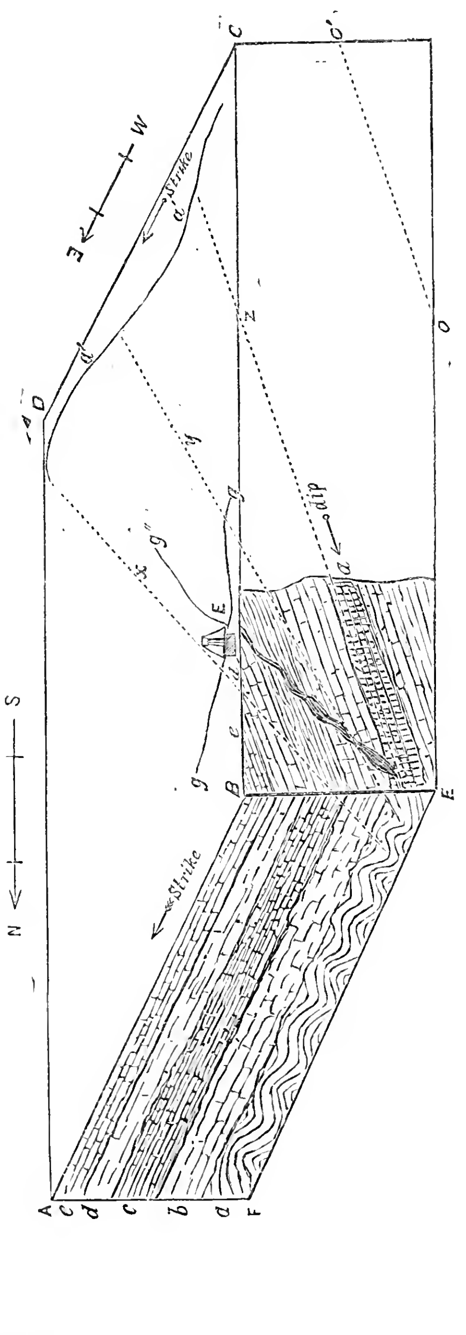
The rake veins in the Ecton district are usually a series of vertical fissures falling in with the pipe veins, and, occasionally, passing

through them. These veins are seldom highly inclined as regards the relationship of their plane to the vertical plane of the rocks; and considered with regard to their contents, only become productive in the immediate vicinity of, or at their conjuncture with, the pipe veins. It is, indeed, questionable whether they may exist even as fissures at any very great distance from the pipes; at any rate, their origin may be safely assumed as contemporaneous. They are not often twitched, or, in other words, the spaces between the walls seldom present any great irregularities of size, such as commonly arise where the edges of the strata, originally opposite, by the nature of the fault are brought to different levels. The direction of the rake veins varies, but a great number have been observed to run north-north-west to north-west. Crossing them, usually at nearly right angles, are other similar veins, which however must not be confounded with another set of great fractures which extend east and west, or nearly so, through a considerable extent of the country, and frequently intersect the saddle-beds in the direction of their strike. These fissures are locally known as "lums," this name having an analogous signification in mining language with what are elsewhere called cross-courses, although they differ essentially from these both in their mineral contents as well as in their effects on the veins with which they are associated and cut across.

The lignograph, fig. 3, represents an ideal block, or parallelopiped, of the country in the neighbourhood of the Ecton and Dale mines without reference to the surface, and exhibits the strata, 1st, as they would be seen in vertical section on their line of strike; and 2nd, as they would be seen in vertical section in the direction of their dip. The plane *A B E F* shows the contorted beds, or saddles, and those which are superincumbent but not contorted, *b c d e*: *A B E F* is also the plane of the cross-course, called the lum, which consequently intersects the saddles vertically. The general features of the pipe-vein *E E′* in this diagram have been already explained, but *E g*, *E g′*, *E g″* will show the connectionship of this vein and the rake-veins, as seen in plan; the bearing of the rake-veins is north-east, south-west, and south-east. The gradual dying out of the contortions towards their crop at the surface, where they form, as already stated, merely waved strata, *a′ a′*, explains itself by the dotted lines *x y z*. The dotted line *o o′* is supposed to proceed from saddle-beds much lower in the series (see also p. 365), and which consequently crop out a great deal farther to the south.

When considering the origin of metalliferous accumulations whether in igneous or stratified formations, any peculiarities in the composition of the rocks are as important to notice as are differences of structure in the same rocks. It may be, therefore, here mentioned that many of the beds in the vicinity of the saddles, at Ecton and elsewhere, are highly charged with silica—either in a segregated form as pseudo-strata intercalated between the coursings of the stone, or by a species of pseudo-morphism: a bed of limestone, while retaining many of the marks of its sedimentary origin, is wholly, or

Lign. 3.—Ideal Parallelopiped Section of Limestone Strata.



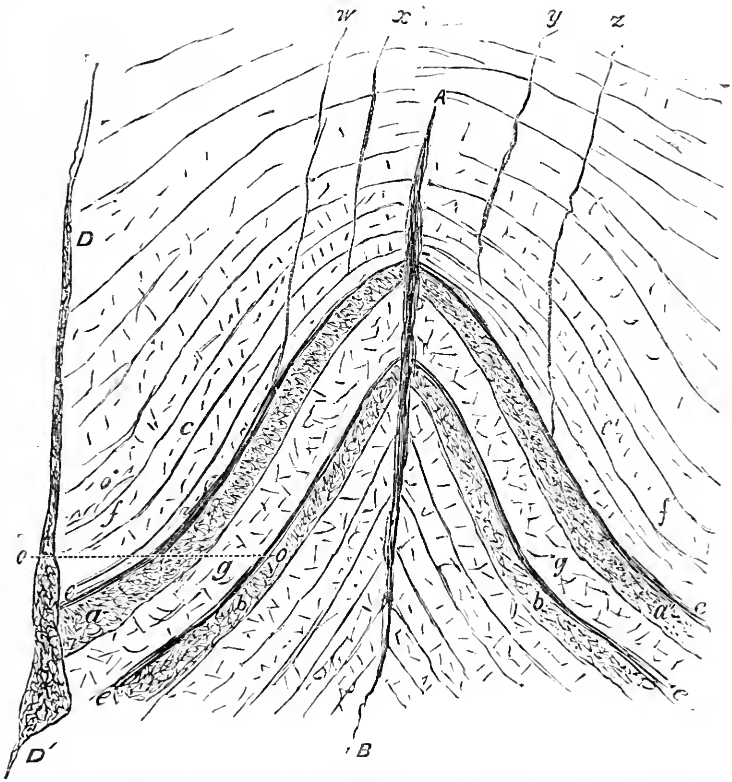
Ideal parallelopiped section of limestone strata, showing the relationship of pipe- and rake-veins with the saddle-beds and "lum" (cross-course). Ecton and Dale mines, North Staffordshire.

in part, converted into silica. Most of these siliceous beds, however, are composed of a description of granular calcedony, or chert, commonly of a dark grey colour, inclining to and passing into black, semi-opaque, and having its surface and fissures often lined with minute pyramidal crystals of quartz. These chert beds do not appear to have any direct connection with the ore-deposits, but their history, in other respects, as I shall presently show, may undoubtedly have a bearing in the general question of the origin of the various phenomena embraced by the dynamical theories involved in our subject.

But we must now turn to the metallic contents of the fissures. The pipe- as well as the rake-veins, are invariably mineralized with sulphuret of lead (galena ore), mixed with a small quantity of sulphuret of zinc (blende), which is deposited in the ordinary layer-like form on the walls of the fissure, and accompanied by a gangue or rain-stone of carbonate of lime, barytes-calcite (carbonate of lime and baryta), cawk, or the massive variety of sulphate of baryta, dreelite (sulphate of baryta and lime) and strontianite. Sometimes, nevertheless, the pipe-veins enclose large separate fragments or lumps of ore embedded in soft decomposed limestone, and unaccompanied by any true veinstone. Such occurrences are not infrequent where the veins squat—that is a line, after passing from one set of beds to another set situate below them, the pipe swells out in a direction parallel with the coursing of the last entered stratum. (See the section of the pipe-vein in the diagram fig. 3.) When the pipes come down to the saddle-beds, they commonly expand in size rapidly, the quantity of ore increases, and the vein assumes a more banded structure, the vein-stone alternating with ribs of ore; at the same time their is an augmented flow of water, and the adjoining rock, or country, is thickly threaded with small ore-bearing fissures. At such junctions large deposits are the rule—that is to say, if the pipe has previously borne ore; and any very considerable returns are seldom expected until these points are reached, unless, as is rarely the case, the rake-veins are found to be very rich at their intersections of the pipe-veins above the saddles. The first appearance of the contortions is marked by a universal fissuring of the rock, most of the fissures bearing ore, and the ceasing of the pipe to retain any longer the distinctive character of a separate vein.

A rude representation of the arrangement of the ore in the saddles after their intersection by the vein is given in fig. 4. *A* marks the buckle or crown of the saddle, which is usually unmetalliferous; *c c′* are the wings, and on them are some of the principal deposits of ore, *a a′*; *B* is the saddle-joint, and is commonly ore-bearing for a limited distance, vertically between the buckle and the trough, the ore dying out below; the troughs are marked *f f′*, and are the parts richest in ore, *a a′*, very large and solid deposits being often encountered at these points; *D D′* is the trough-joint, usually more productive than the saddle-joint; lastly, *w*, *x*, *y*, *z* are mineralized fissures running up to the pipe, and often containing ore solid enough to be worth follow-

ing, while sometimes they are also sufficiently numerous to repay the cost of removing the whole of the rock containing them. But the ore-bearing parts of the saddles extend in reality to two separate sets of beds, distinguished as the *thick* and the *thin* beds, *f f'* and *g g'* (fig. 4), the latter being immediately under the former. The mineral, *b b'*, is associated in the thin beds, *g g'*, under nearly similar conditions to



Lign. 4.—Vertical section of the "bearing beds," showing the mode in which the ore is deposited.

those which have been described above for the thick beds (*f f'*); the ore deposits in the former are generally worked by driving cross-cut levels from the troughs of the thick beds (see dotted line *o o'* in the lignograph). No true vein-stone accompanies the ore in the saddles, but crystallized calc-spar is not unfrequently plated with ore on the cheeks of the fissures, and spar also exists beneath the ore on the

wings. In place of a vein-stone, however, there are certain accompaniments of a peculiar condition in the rock which are considered by the miner as bearing unfailing testimony of the proximity of ore; these guides are called the "weigh-beds" (*e e' e'' e'''* in diagram), and are composed of soft decomposed limestone much resembling (although possessing an entirely different chemical composition) the clayey contents of the "slides," and often "cross-courses" associated with the lodes in Cornwall, and there termed "flookan." The position of these beds is immediately overlying the ore, both in the thick as well as the thin beds (see lignograph), but particularly the latter, where the "weigh" is said "to change into ore." The collective term in use for the various mineralized portions of the saddles is "bearing beds." Cutting across the saddles or bearing beds, as has already been mentioned, are the east and west fissures called "lums;" their veins are usually of great magnitude, and are commonly entirely filled with marl and decomposed limestone, although in the immediate neighbourhood of the pipe-veins some ore proceeding from the saddles is mostly found attached to the cheeks of the vein.

But if there is a great change in the structure of the vein, and the mode of deposition of the ore when the pipe-veins come to intersect the bearing beds, the change in respect of the nature of the minerals is greater still, the ore in the pipe and rake-veins being lead, while that in the saddles and limestone is almost always copper; some lead as usually found at first in the saddles, but as the beds near the limestone the proportion of copper ore invariably increases, until the whole deposit consists of this mineral. The distance to which the ore is deposited in the bearing beds laterally divergent from the point of intersection of the pipes, amounts seldom to more than two or three saddles' breadth on either side, although there is no rule in the case; the transverse deposits, *i. e.*, those which are parallel with the saddle-joints, either on the wings or in the troughs entered often as much as eighty fathoms in one direction from the point of intersection with the pipe and limestone, and inasmuch as the limestone as stated above usually contains some ore at such points of junction, the saddles are in such cases said "to carry away the ore."

The description of the mode of occurrence of the ore in the bearing beds as well as in the pipe- and rake-veins, in the preceding paragraphs is a fair *resumé*, I believe, of the aggregate of the observations of the most experienced miners in the districts lying north, west, and south of Alstonfield, both in Staffordshire and the neighbouring county.

From the consideration of appearances we naturally turn to the causes which have produced them; and although it forms no part of my intention to give more in this article than something like a connected account of the phenomena observed in these metalliferous saddles, as entered among my notes, there are yet some questions respecting *the history of the facts* which need a brief recognition in this place. It has already been assumed that the plication of the beds has arisen from pressure laterally applied, and the origin of the

changes may be attributed in general terms to subterranean disturbances. A glance at the geology of the neighbourhood to which our observations apply, is sufficient to show by surface evidence alone that the country, to anglicise a useful French geological term, is *accidented;* and we may consider the whole of the changes, whether mechanical or chemical, to have occurred subsequently to the first formation of the rocks. What is more, if we attribute the presence of the bands of chert to the separation of silica from hot springs during the deposition of the strata, we may fairly assume that the rocks themselves are formed over some old focus of disturbance; and in this way the siliceous beds may be considered as remotely related, as once before observed, to the chain of first causes in the history of events. We may infer, then, that the dislocations of strata giving rise to the irregularities of the surface, and probably the greater part of the veins, fissures, and joints have resulted from elevatory forces uplifting wide tracts of country with energy varying in intensity and unequally applied. For the plication of the strata, the in-filling of the ores, and the general molecular changes in the rock composing the saddles, we must look to another cause, the opposite of the above, namely, depression. And if we reflect for a moment on the change of volume that takes place in solids when affected by high ranges of temperature, not sufficient to produce in degree any other change, it will be evident that any large mass of strata carried below the stratum of invariable temperature and exposed, it may be, for centuries to a regular, though not necessarily very high, temperature, will, if afterwards elevated, display marked effects, partly mechanical, partly chemical, of the action to which it has been subjected. The expansion of rocks in the direction of their length has been made out for each increment of one degree of Fahrenheit above the ordinary mean temperature at the surface, and by these experiments we learn that if a mass of limestone one hundred miles in length be removed by subsidence to a depth of about two miles below the stratum of mean temperature*, where it will encounter an elevation of one hundred and eighty degrees Fahrenheit beyond the mean temperature of its original position, it will undergo a lineal expansion amounting to about five hundred and forty feet. But such an increase in length could not fail to exert, if opposed by any adjoining resistable rocks, aided by superincumbent pressure, a very marked effect upon all the *compressible* strata of the limestone, squeezing and contorting the beds after the manner observed; and at the same time it will be evident that long exposure of the rocks to a perfectly even and regular temperature would tend to produce great molecular change, and probably a semi-crystalline condition. In connection with this therefore, it is well worthy to be remarked that these plicated beds which I have been describing are perfectly devoid of organic remains, while the beds above and below

* The stratum of mean temperature lies in latitudes forty-eight degrees and fifty-two degrees north, at a depth of about sixty to sixty-four feet.

them are loaded with fossil debris, particularly the stems of encrinites. It may be argued that as the contorted beds occur at intervals among the other beds, they must have possessed some peculiarities that caused them to undergo such great mechanical changes, while the other beds are comparatively unaffected. It may be answered that this was probably the case, and that these beds, moreover, are exposed by circumstances to a greater amount of compressing force; for it must be borne in mind that *all* the strata show more or less of contortion, and that it is only in limited areas that the bearing beds themselves exhibit the phenomenon in the utmost degree, inasmuch as there is an almost undistinguishable difference in this respect between these strata and the others at their crop*, as before observed. The mentioning of these facts is necessary, lest it may be thought that these contorted strata were formed and transformed previously to the deposit of the overlying beds, against which supposition there is every evidence.

But to return. During the re-emergence of the mass of the strata, for which we have been supposing the changes above imagined, we may conceive the dislocations and separations of the beds, whether separately between themselves, as in the saddles, or in whole masses, more or less vertically, as in the veins, to have occurred. The complicated fissures forming the pipe-veins, with their associated rake-veins, were in all probability formed simultaneously with the fissures in the bearing beds. It the same time, it is likely that the great east and west faults called the "lums," were of more recent origin, and formed by a wholly separate system of dislocations; and it may be taken that the saddle-beds are the lines of least resistance, along which these last manifestations of the disruptive force displayed themselves. Moreover, there is great reason for supposing that the infilling of the fissures and joints in the bearing beds, with their cupreous contents, were effected through the media of the lums which were thus formed. The lead, on the other hand, was probably supplied to the pipe-veins through the agency of their intersecting rake-veins, which continue to descend independently of them to unknown depths, and are probably the channels through which the plombiferous menstrua originally ascended.

The parts stated at the conclusion of the last paragraph point to a remarkable natural distinction between the saddles and the pipes in

* The outcoming of the bearing-beds is recognized, among other appearances, by the more crystalline character of the limestone, but with the exception of the occasional presence of the peroxide of iron, there is nothing to indicate the metalliferous condition which obtains in them elsewhere; and, it may be, though I have no positive knowledge of the fact, that their unfossiliferous state, as remarked in the text, is also only partitive. It is not difficult to imagine that the intense squeezing, necessary to produce the often fantastic contortions of the ore-bearing parts of these beds, would be sufficient to crush and obliterate any remains of organisms previously preserved, particularly if aided by any subsequent arrangement in the molecular agglomeration of the rock, of which there is abundant evidence in, at least, the productive portions of these strata.

the nature of their ore contents, and, partly on this account, it has been remarked at the commencement of this notice that the saddles must not be classed indiscriminately with, but rather must be considered apart from, the general vein-system of the districts in which they occur. Of course the separation cannot rest alone on the ground of a change in the description of the ore, since many such changes, and often from lead to copper, frequently occur in depth in true veins. The real distinction lies in the mechanical position of the ore, which, it would seem, gives a classification for the saddles between veins and bedded deposits; and this arrangement will be further confirmed if, considering that the latter mostly comprehend mineral accumulations introduced from above, and the former those injected from below, the agency of the lums be regarded in a two-fold light—first, as originally giving passage to copper-bearing solutions, with which their other mineral contents were at one time largely impregnated; and, secondly, by afterwards permitting a free electrolysis of the salts by which the copper was determined to the fissures in the saddles, and by then, or after, acting chemical changes resolved into sulphurets (copper pyrites) as now found.* Thus conceived, the segregation of the ore in the saddles is a special phenomenon, and deserves, as I hope I may have succeeded in some measure, at least, to show, a separate and attentive consideration at the hands of physical geologists. It is not to be confounded with what in Flintshire and elsewhere in the mountain-limestone mining-districts are termed "flats," or "flat veins," notwithstanding that it more nearly resembles those descriptions of deposits than any others. Still it is widely different, since as on one hand flat veins, as their name implies, are, comparatively speaking, horizontal veins, and often occupy a plain corresponding irregularly with the stratifications, so, on the other hand, the constant position of the ore in certain beds, as well as certain parts of those beds, is, beyond all doubt, the distinguishing peculiarity of the general phenomena of the saddles.

In the foregoing observations I have endeavoured to describe as nearly as possible the average of the appearances presented by the bearing beds of the Ecton district in the limestone; but, as before mentioned, the same phenomena are observable in the Upper Limestone shales. They do not, however, merit any separate description beyond the statement that they are similarly mineralized, are equally traversed by lums, and have the same mechanical relations with the neighbouring veins and with the associated strata.

* Where galena is the associated ore, copper seldom occurs in any other form than as copper pyrites, a fact worthy of remark in connection with the paragenesis of metallic minerals.

GEOLOGICAL TOPICS.

THE FIRST TRACES OF MAN ON THE EARTH.

(Continued from vol. ii., page 482.)

The first person to verify the geological age of the flint-implement strata of the valley of the Somme was Dr. Rigollet, who in 1854 published his "Mémoire sur des Instruments en silex trouvés à Saint Acheul près Amiens, et considérés sous les rapports Géologique et Archéologique," * illustrated by five sections of the beds by M. Dutilleux, and with drawings of the worked flints. After stating that on many occasions the bones and teeth of fossil elephants had been met with in the same beds, he adds—"My curiosity was strongly excited in the month of August last (1854), when M. Dutilleux, Member of the Society of Antiquaries of Picardy, informed me that he had found there also axes or instruments of flint evidently worked by the hand of man. This fact, however astonishing, was the less so as M. Boucher de Perthes had announced the like discoveries at Menchecourt and at the mill at Quignon, near the gates of Abbeville."†

Feeling that these discoveries supported the statements of M. de Perthes, Dr. Rigollet thought the geological question the most important, and the first to be investigated.

Accompanied by M. Buteaux, member of the Geological Society of France, and author of an excellent memoir "On the Geology of the Department of the Somme," Dr. Rigollet inspected the beds themselves. He induced also M. E. Hébert, the professor of geology of the Ecole Normal Supérieure of Paris, who for many years had spared no labour nor travel in the special study of the quarternary deposits, to visit the excavations at Saint Acheul and Saint Roch, and the deposits at Abbeville, and to inspect the rich and curious collection of axes and worked flints of M. Boucher de Perthes.

"At Abbeville, as at Amiens," says Dr. Rigollet, "the worked flints are met with solely at the lower part of the diggings, in the midst of the sand and gravel. Some of those found at Saint Acheul are still covered with a calcareous coating that at certain places envelopes the boulders and gravel, and which adherent gangue is met with only in this stratum, and is not seen in any of the overlying beds. At Saint-Acheul, from the same place where these products of human industry are met with, M. Dutilleux obtained the tusk of an elephant, and bones and teeth of extinct species of horse, ox, and deer, the substance of which is dense, and heavy, as if impregnated with calcareous and perhaps siliceous matter, and totally unlike the bones of men, oxen, or horses found in superficial deposits, which are porous and light, even when they date back for fifteen or sixteen hundred years."

"Thus it is well established," M. Rigollet adds, "that these flint objects are not found in the brick-earth which forms the uppermost stratum, nor in the intermediate beds of clay, sand, and small pebbles, but are met with exclusively in the veritable *diluvium*." M. Rigollet collected upwards of four hundred of

* Amiens, 1854, Duval et Herment.

† Part of M. Boucher de Perthes book was translated and embodied in "The Stone Period," by Dr. A. Hume, of Liverpool, in 1851.

these flints, all worked in the same manner, although for different purposes. "For the most part there is a general resemblance of form, which is ordinarily a flat oval, of which the upper part or thick end is smooth, remaining in its primitive state, while the sides and point are sufficiently sharp to have permited their use without recourse having been had to grinding.

"Others resemble a dagger (poignard); and some have the form of a triangular pyramid, of which the fastenings (aretes) are very irregularly hollowed out by the conchoidal chippings of the flint. The figures we have given will convey the form of these productions of so remote an age; their medium size is ten or twelve centimetres in their greatest diameter. There are others in which this dimension is only eight centimetres, and some in which it is twenty-four centimetres.

"When one has seen some of these stones, they can be recognized immediately as belonging to the diluvium. Those which M. Boucher de Perthes has found in the same deposit at Abbeville have a like form and are worked in the same manner. I could not say what has been their use; and on this subject every hypothesis ought to be carefully excluded, and we should content ourselves with stating the facts in all their simplicity."

M. E. de Marsy also published a work on this subject entitled "Rapport sur l'ouvrage de M. Boucher de Perthes ayant pour titre, 'Des Monuments Celtiques et Antédiluviens'" (12mo., 1855).

M. de Perthes now devotes a chapter of his book to "the erratic blocks, flints, and animal debris transported by ice."

"This may at first appear foreign," he says, "to the subject of this book, but one will soon see why I insert it, and how transportation by ice has contributed to the formation of some deposits, and consequently to the commingling of objects brought from many and often distant points. Hence one ought not to be astonished at finding in the diluvium debris of various origins, or bones of animals which have not inhabited the same lands, and even of the arms, signs, and instruments of stone worked by men who lived perhaps in very different countries.

"How the ice has been able to transport the boulders, the bones, and the different detritus which compose these tertiary layers and analogous deposits I will now try to explain by the ideas which struck me for the first time when I traversed the glaciers of the Alps, and since when I have seen on the peaks of the Pyrenees, on Etna, and other mountains those masses of snow of which the origin is lost in the night of Time, for if the superficial layers melt and are renewed, the snow beds below remain always the same. In what manner, then, were those first snow beds formed? Why have they not annually disappeared like those which have followed them?

"It may be thought that at different epochs there have succeeded without interruption, during periods of more or less duration, violent storms of snow, of which the consolidated masses have at certain points overtopped the trees, filled up valleys, and enshrouded mountains, the earth for a great part of its surface presenting an immense plain over which there reigned but one season—winter.

"This snow has consolidated and maintained itself throughout a vast period of time; at this hour even it has not entirely disappeared, we see its remnants in our glaciers.

"It was the melting of the snow of the plain and on the slopes of the mountains which produced a last deluge. But before this deluge swept the earth, it is possible that entire families, especially of the herbivora—deprived of food, since it was buried under that icy sheet—had been annihilated; or if they were not suddenly destroyed, the alteration of climate would have arrested their reproduction. One can comprehend that from this snowfall, and from its continuance, there would have resulted a great refrigeration of the atmosphere

even in those countries which the storm had spared. Thus in France, where palms and a tropical vegetation flourished before, by reason of the change of temperature, only northern plants would be produced, or those which we see there now.

"For the same reason the animals of hot climates of which we find the bones would have ceased to appear there, and to multiply. It might be objected that the cause being destroyed and the snow melted, the effect ought to cease, and the temperature to return to what it previously was. Truly, if this thaw had been universal; but it is not so, witness the polar ices and all the glaciers of the mountains; witness also the colder aspect of all the uppermost strata of the earth,—a reduction of temperature which may have dated from this very cataclysm.

"What would tend also to prove, up to a certain point, these deluges of snow are the skeletons of mammoths found in Siberia with their flesh. Suffocating them on the spot at the moment when they were full of life, that snow, since transformed into solid ice, could alone accomplish such a result. One can comprehend, too, how these animals, flying from the sudden and violent storm, were arrested by the sea, and when entirely covered by the snow, since frozen and hardened, their bodies have been, so to speak, eternalized, for they would have been able to endure for millions of years still in the same state, if the amelioration of the temperature or some fortuitous circumstance had not brought about the melting of the ice which enveloped them. Hence the quantity of their bones which still covers Nova Zembla and a part of Siberia, bones so well preserved that the ivory of their tusks is esteemed nearly equal to new. It is then perhaps at the bottom of some glacier, under some avalanche, or in one of the enormous blocks of polar ice that we shall find antediluvian man; and it will not be merely his bones that we shall see, but the man entire, such as he was when, put to sleep by the cold, death surprized him, and the icy preserving winding sheet enveloped him like a fly in amber.

"The world will treat this as a revery; but how many fertile foresights, which our fathers had treated as fables, have been realized? How many others rejected in our incredulity will be manifest truths to our descendants? Leaving here the speculative, and returning to the positive, we regard this deluge of snow as the result of a sudden cause which has not yet entirely ceased. The polar ices and our glaciers date not from the creation of the globe, and many ages have elapsed before the earth received these icy showers. Moreover, at the end of the snowy cataclysm, and even after the great breaking up of the ice and the deluge which followed it, the glaciers were more considerable and extended much farther than in our time. Blocks of ice broken out by the waves and from seas remote floated within sight of our coasts. Stranded by the tempest, or by the heaving of the waves, they covered entire regions even in the temperate zone. In their melting they have left on the soil those masses of granite, of sandstone, and other rocks which are called *erratic blocks;* masses too ponderous to have been brought where we now find them by the effort of a mere current of water.

"The position alone of these blocks would prove that they had been placed there not by a simple horizontal impulsion, but by a perpendicular action, that is to say, by a successive sinking, or a movement from above to below.

"Placed in the interior of the iceberg, or perhaps on its surface, each block, in proportion as the ice melted, sunk nearer to the ground or upon another block which before it had taken there its erect position. It is then on the soil, or on the first sunken block that the second finds a basis where we now see it, as upon a pedestal.

"One knows not otherwise how to explain these superpositions of stones, for no human force could have raised them, and one cannot comprehend

how it could be done by a current of water, however powerful it may be supposed. A torrent overthrows but does not pile up.

"One sees, then, torn off at their base by the weight of snow, these rocks precipitated from the mountains in their icy envelope, launched afterwards into the sea by the waves and torrents or by their own impulsion, driven by the winds and currents from ocean to ocean, just as the polar icebergs still are. These have been carried towards the coasts, and afterwards by the irruptions or conflux of the seas thrown over the interiors of the lands. There, when their icy vehicle has disappeared, they were dropped on the soil where we see them at this hour, demanding of us why they are there when no other analogous production shows itself either in the vicinity or even in the same region.

"If we admit the carriage of these granite-blocks and others by ice, there is still greater reason for recognizing the possibility that the smaller bodies, bones, and debris belonged originally perhaps to latitudes very remote.

Although we can not concur in the very speculative view set forth in it, nevertheless, M. Boucher de Perthes' third chapter "on the affinities of form and use of the stones called 'celts' of all epochs and of all countries," is one of considerable interest. Here he justly observes that what has mainly prevented their study being seriously taken up has been the want of books upon the subject. "If some ancient authors," he says, "have spoken of them, it is incidentally, and without attaching any great importance to their origin, or saying a word about the circumstances of their discovery, or the place whence they have come. In none of the States of Europe, except Denmark and Sweden, have I seen any collection of them which deserves that title. The objects exposed in our museums without any certificates of their origin, may contribute to the ornament of a gallery, but not to the progress of science. Isolated thus, they tell us nothing of the history of men, nor of their first steps upon the earth.

"I have endeavoured to avoid this reproach of isolation or doubtful origin by not admitting as typical a single fragment of which the circumstances were not perfectly reliable, and which was not accompanied by a sample of the earth whence it came.

"That which strikes us at once in these thousands of worked flints from all parts of the world is their general likeness. Gathered from the turf-pits of the Somme or the marshes of Sweden, Denmark, or Greenland, they resemble each other so much that one would think they were made by the same workmen. Moreover, between these productions of the north and south, between these industrial essays of nations separated by the seas, there is a striking resemblance, which becomes more apparent as the objects are larger and simpler.

"When one reflects upon it, this does not differ from that which daily passes under our eyes. Children in every country have the same delights and the same desires—hence even the same playthings. If they have not got them, they invent them and make them.

"Thus, too, the primitive peoples—those great children of Nature—have acted: all had the same weapons because they had the same passions. Everywhere alike is it that with a club, a stake, or a sharpened stone, men have begun to kill each other when they have thought that their hands were not sufficient.

"Everywhere, too, similar wants have necessitated similar tools and utensils. Knives, vases, combs, spades, bows, arrows, fish-hooks, have been simultaneously invented by peoples without communication with each other.

"Not only have these races had need of arms, household goods, and tools, but they required also finery, idols, amulets, talismans, and ornaments, and lastly, commemorative signs, which, substituted for word and gesture, took the place of

figures and writing; for there is no tribe so poor, so brutal, so little advanced as entirely to do without them.

"It is to the collecting of these signs, in bringing them together and comparing them, that I have specially devoted myself. Before arranging a manufactured flint in the class of types, I have assured myself that this type was met with in various localities. A single example was no proof; I only admitted those of which I had assembled a certain number of like examples.

"We distinguish amongst the drawings which I have given the flint types or characters from those which are not. Since my last publication I have augmented the number of these characters, which now exceeds that of the letters of our alphabet. That I may be forgiven for this comparison, it is not so hazardous as it seems; for in these hieroglyphics of stone I believe I have seen a revealing of the primitive writing, and the original means of transmitting thought beyond speech.

"I have searched closely for the key to this language of stones; but for a much longer time was that of the hieroglyphics asked of ancient Egypt, and it is only in our days that Champollion found it. We do not despair, then, of arriving at the explanation of these antediluvian signs. Less numerous and less complex than the Egyptian and Assyrian hieroglyphics, they ought to be of easier solution.

"Resuming our preceding subject, we say these signs exist, that is certain; that they are also the work of men cannot be doubted; and that they are not the result of a simple caprice is proved by their number and their constant analogy.

"If they be the work of men, and a work repeated from generation to generation, the work must have had an object and an application. The primitive men would have been more simple and more ignorant than we are—that is to say, would have had less experience, fewer topics of remembrance, fewer terms of comparison, and hence embracing fewer and less profound ideas; but they were not, any more than ourselves, wanting in sense, nor would they, any more than we would, take trouble for nothing—that is to say, without any object or any need. If they have made signs, if they have made them in great numbers, it is because they were useful.

"Now if it were neither as trinket nor utensil, it follows that it was as a means of being understood—as an intellectual or religious, representative or commemorative sign—a sign materializing a thought, rendering it palpable—in short, representing a divinity like our idols, a value like our money, or a perpetuation like our writing.

"Of all these versions, whichever we may adopt, one can but see in these types of stone the result of a thought, the desire to transmit it, and to render it enduring.

"If these signs are ranged in a certain order, if in their diversity they have amongst themselves similarity of material, size, make, or workmanship, it will be still more difficult to doubt that by their relationships it may not have been wished to extend and complicate the idea—that is to say, to create phrases by the combination of words, and of pages by the linking together of phrases?

Writing, such as civilized peoples understand and practice it, is a science; but this science, so complex now, has not always been so; like every other created thing it has had its beginning. This beginning has been simple, as it is still amongst savages; for, I repeat it, I do not believe that any are so absolutely unlettered, ignorant, or unintelligent as not to have any scripture what ever. Is there amongst ourselves a man reputed to know neither how to read or write that has not his own? Ask this clown, this mechanic, this labourer—he writes his accounts in his own manner, but he *writes* them.

"So also all the burrowing peoples; they write on the sand, on the trees, on the rocks. It is thus that they indicate their meeting places for war, for the

chase, of love, or of holiday. By conventional signs they announce to their friends their victories or their defeats, the number of their killed and of their prisoners. By the number or the form of the stones placed on his sepulchre they explained the name, the quality, the exploits of a defunct chieftain. While alive he had made them write them on his body by means of tattooing, which is less a mere ornament, as it has so long been thought, than the biography of the man and of his ancestors.

"These traces drawn upon the earth, these trees, these rocks, these stones placed in certain order or grouped in varied number, such was the first writing of these antediluvian peoples. Men like us, those first-born made that which we have made since. As their ideas enlarged and complicated themselves they complicated also the means of communicating them; their signs became more varied, more complex, more moveable. Not finding everywhere these signs or the material proper to fabricate them, they carried them with them. It is thus that the Romans carried with them their penates and their household-gods. Some Asiatic and African nations still do the same; their relics and their gods are the characters of their tongue. With us also has not each saint his symbol?

"If each individual or head of a family had had only those signs which belonged to himself they would have been understood by those around him, as his wife and his children, but he could not have communicated with his neighbour. He had, then, besides these special signs, or, if you please, this household language, general signs intended for all. Hence the analogy of types from distances so great and in countries so different. They have been introduced as men, becoming more numerous, spread out from the cradle of their forefathers."

It is thus our French author has let his imagination have play, and persuaded himself that he has found out the characters which constituted the first and universal *material* language. We cannot say that on this point our faith is great in the accuracy of M. de Perthes' conclusions, but his speculations are suggestive; and we have more than once turned our thoughts from these ethereal theories to those great monoliths (of which the so-called Druid stones and Druid circles in our own lands are examples) that are found seemingly distributed nearly all over the world, presenting in regions far apart from each other remarkably similar characters;—everywhere massive; of local material; of the simplest workmanship; everywhere older than every other architectural erection; everywhere of unknown origin; and everywhere with the strongest marks of the highest antiquity. Is it possible these may be the venerable monuments of the first wandering nations? I know, of course, the opinions of our best antiquaries on British monuments of this class; but I am by no means persuaded of their sepulchral origin, still less that many of them have ever been covered by mounds of earth. Not a stone, nor a coin, nor a relic of any kind has ever been discovered in or near them that could give a datum to their erection. And the situations in which they are placed are very remarkable and different from those usually selected for burial-mounds, or barrows.

I think there is no point bearing on these remarkable discoveries of stone-weapons which should not be thoroughly considered before rejection. From the wildest theories at this moment we may be led to the discovery of important facts.

The way in which M. Boucher de Perthes accounts for the great number, in certain localities, of these flint objects is singular and fanciful, and the passage is worth transcribing.

"Any one visiting me may count them by thousands, and yet I have kept only those which presented some interest. From those beds which I have called "celtic" I have seen them drawn in barrows to metal the neighbouring

roads: one would have thought a shower of them had fallen from the sky. I have explained this by the passage of an army, of which each warrior would believe himself under the obligation of throwing one of these stones, more or less worked, on the sepulchre of a chief, or on the place where he had been killed. And the multitude of signs is only a small part of those that existed, for all those, the material of which was woody, soft, or soluble, have disappeared."

Resuming the previous topic, M. de Perthes concludes his chapter with the following remarks:—

"Icebergs floating from one sea to another will explain not only the presence of rocks and of minerals in countries where there exists neither quarry nor vein of them, but also the mysteries of spontaneous vegetation, or the sudden appearance of beings previously unknown. Bulbs, grain, germs, eggs, chrysalides, and larvæ even, protected by those walls of ice, braving all temperatures, all shocks, all contacts, could they not preserve almost indefinitely their vital power and their productive virtue? Have there been made in this respect all possible experiments, and is it known up to what point ice is the protector of life? Snow, is it not so? Are there not numerous vegetables and even animals that it defends from the destruction which would be brought upon them by the sudden variations of the atmosphere? Does even the most intense frost kill certain creatures? No; and frogs frozen to the extent that there limbs break like glass have been re-animated by a gradual transition from this excessive cold to a moderate temperature. In our ponds are there not fish and insects seized by the ice, which, seemingly dead, revive in the spring?

"One ought also to look at the question under its purely geological relations, and decide if the ideas that I have mooted on the transport of erratic blocks by floating icebergs could not be applied to the formation of certain banks or deposits. That would inform us how these worked stones are to be found on points very far from those whence they had come.

"After the necessary investigations on the movement of the glaciers of the Alps, on the augmentation or the reduction of their masses, could we not establish some calculation as to the greater or less antiquity of the last great invasion of the snows, and of the inundation which would have resulted from their sudden or gradual melting? If a part of our rivers were fed by the draining of snow-water, it is evident that the mass of the waters of these rivers ought to have decreased with the diminution of the fall of snow. Everything tends to show that water-courses, at present hardly navigable, have been deep rivers. Our largest European rivers, if one judge by the extent of their valleys, which in their entireties ought to be their ancient beds, had thus ten times more water than now-a-days. This reduction has been attributed to the destruction of forests, which certainly ought to go for something; but, according to my ideas, the decrease of the mass of snows has contributed much more to this result. Lastly, why does less snow fall than formerly? These deluges of snow, are they periodical? Should we see again some day the earth re-covered with this winding-sheet, that for ages to come would throw it into a sleep of death from which it would only be drawn by another watery deluge, would this deluge, by its fecundating oose, restore to it its vegetative heat, and its first fertility? Great questions.

"Without seeking to read the future, let us profit by what we have under our eyes to enlighten the past, and let us not reject the light which we have."

(To be continued.)

ON THE OSSIFEROUS CAVERNS AT ORESTON.

By Henry C. Hodge.

(*Continued from page* 344, *vol.* iii.)

In concluding this paper, allow me to remark that if the deductions to which I have arrived be correct, some data will have been afforded for explaining, through the agency of analogous chemical changes and their resulting products, the cause of some, at least, of the various distinctive characters presented by those rocks which constitute that portion of the earth's surface formed from the decomposition of previously existing rocky masses. I will not, however, take up your time with any lengthy arguments to strengthen my position in such a manner, but will merely attempt to give a very brief description of what I conceive we may not unreasonably infer has taken place during past ages of the world's history, remarking on the various geological formations in the general order of their occurrence; and, firstly, I would direct attention to the important bearing the chemical changes described may be presumed to have on the solution of the question as to the geological equivalence of the Old Red Sandstone rocks of Scotland to those of our Devonian era. I have before adverted to the occurrence of red sand in a decomposed slaty seam of the Plymouth limestone, and would add that such red sand is a frequent result of the decomposition of its dolomite, and that sandy beds of a similar kind are also not unfrequent in the limestone itself. If we call to mind the fragmentary condition of the fossils of the Old Red Sandstone strata, it may not be considered unreasonable to suppose that they have been formed from the decomposition of rocks similar to those of our Devonian limestones, in which iron pyrites was much more abundantly distributed. If this be true, there must have been generated at this period an enormous quantity both of carbonic acid and of sulphate of lime—the former no doubt required for the sustenance of the luxuriant vegetation of the succeeding coal period, and a most active agent in producing similar chemical changes to those I have just now endeavoured to explain—and the sulphate of lime, under the reacting influence of the organic matter (assisted by the high temperature of that period), being changed to sulphide of calcium, and simultaneously, through the influence of the carbonic acid, again becoming resolved into carbonate of lime—changes still traceable in the waters of the present day. At the same time, too, with the formation of this carbonate of lime, and the presence of such large amounts of carbonic acid, it is reasonable to conclude that the waters might be charged with other salts and carbonates (together with alkaline chlorides, from their solvent action on the substance of decaying plants), viz., bicarbonates of iron and magnesia with those of lime, such depositing with admixed clayey mud:—Firstly, those valuable argillaceous carbonates of iron of the coal measures, and the immense excess of carbonic acid contributing to undermine the foundations of the rocks, and interstratify them with the coal; after this depositing the mountain limestone, and the resulting fluid from these products readily to be obtained from the decomposition of pyrites, now form beds of gypsum, and with sand the New Red Sandstone, and the remaining waters, now almost divested of their lime, proceed to dolomize the submarine calcareous rocks, effacing thus in part the record of their first existing organisms.

Here allow me to remark that gypseous deposits happening to possess a more than very slight degree of solubility, would not entirely sink in passing from the base of decomposing limestone fissures, and there would be formed layers of fresh water on the now concentrated salt (a truth still noticeable at sea), and the supply of gypsum yet going on whilst evaporation from the surface of the fluid layers still proceeded, there would thus be formed beds of rock salt which alternate with gypsum.

During the progress of these changes, abundant herds of chambered nautili and other cephalopeds are sporting in the quiet waters; and whilst the atmosphere is now becoming purified for the reception of air-breathing birds and reptiles, the traces of whose footprints on the sands are even undisturbed by the gently rippling waters, the truly igneous rocks are on the eve of pouring forth their lavas, which (as Fownes has shown) contain phosphoric compounds, these being more abundantly required for the purposes of the seed-producing plants and the supply of bone; and whilst the reptiles of the Lias are by such disturbing causes frequently destroyed, and the delicately sculptured trilobites have entirely disappeared, the agitated waters, charged with our bicarbonates, deposit oolitic rocks, by reason of the numerous shifting grains of sand. Just before the close of these commotions there may be remarked another change, resulting probably (as may be clearly shown from causes now operating in the mineral veins of Cornwall and elsewhere), from the accidental presence of fluorides in our decomposing limestone strata (comparable, perhaps, to those of Derbyshire with veins of fluor-spar), green compounds, differing from mere siliceous sand, and somewhat allied in composition to chloritic rocks, mingling their contents with the settling products. And, now again, there is a period of rest, and whilst the draining of an upraised or still existing westward continent is pouring forth torrents of clayey mud, our bicarbonates deposit chalky rock, which, with the immensely numerous remains of microscopic shells and corals, cover the ocean's bed, and at intervals in which organic forms are favourably found for nucleus, there are formed on it siliceous nodules, in a manner similar to that in which the fossil stems of trees silicify, and comparable in this respect with the septaria from our shales and ironstone nodules from the Gault. Changes still go on, and during these there forms a separating gulf between our Gaulish neighbours and ourselves, and at the same time sink the basin-shaped foundations for their capitals, and where these now stand, strange pachyderms, huge snakes and crocodiles in groves of palms, with monkeys, have their sway; but by-and-bye pouring forth of rivers charged with sulphuric acid from the decomposing iron pyrites of the rocks, and similar to the so-called "vinegar river" of Columbia, at the present time, rushing with violence into these, react upon their loose calcareous strata, decompose their shells, and overthrowing the adjacent banks, bury their mammals in a gypseous mass, dislocating their fragile skeletons, and often leaving only parts of them. To such succeed still more gigantic pachyderms, and very soon mammoths, rhinoceroses, and hippopotami, our varied mammals of the caves, with lions, bears, hyænas, wolves, the machairodus, and other flesh-consuming animals fitted to cope with them, hold their reign; but all this while an elevating action (perhaps resulting from the same causes that overwhelmed the ancestors of these predaceous tyrants), has been in operation, raising whole mountain chains—the Alps, and Pyrenees, Carpathians, Himalayas—having their lofty peaks crowned with the nummulitic limestones, and to this again succeeds, through chemically undermining influence upon the rocks, a period of swift depression, during which the crags were formed through stormy waters lashed into fury by the raging winds, commencing now to change and modify the tainted air, and fit it for the dwelling of a future human race.

But during, and, indeed, before this time, the smouldering volcanos have

been pouring forth their sulphur, and meteoric stones (found by Berzelius and others to contain two-thirds at least of all the elements) fall frequent to the earth; the actively combining oxygen forms with these products sulphate of iron, staining red the crag, and in our oldest rocks deposit minera veins and beds of tin; the oxygen absorbed, reducing action now ensues, and the metallic salts of copper, iron, silver, lead, and zinc form, in the veins of various geologic age, metallic sulphide, just in the order of their differing solubility or disposition for each other; last of all, the noble metals platinum and gold, refusing to combine with such as these, are found in drifted sands with the more ancient streams of tin.

But now the elemental strife increases, some of the openings to our caves are closed, bone breccias are formed, the glacial or boulder-drift and clay conceal the mouths of others, and at length the earth is without form and void, the waters gain the mastery, and over them in darkness moves alone the Spirit of their Great Creator.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—January 18, 1860.

1. "Notice of some Sections of the Strata near Oxford." By John Phillips, M.A., LL.D., F.R.S., Pres. G.S. &c.

From the Yorkshire coast to that of Dorset, evidence of unconformity between the Oolitic and the Cretaceous strata is readily observed. This is especially seen in the neighbourhood of Oxford, where it is difficult to trace out correctly the limits of the Lower Cretaceous beds. The Oolitic rocks having been deposited whilst the relative position of the land and sea was being changed, many of the deposits are subject to local limitation; thus the Coralline, Oolitic, and the Calc-grit die out rapidly, and the Kimmeridge Clay comes to rest on the Oxford Clay. It is on the denuded surface formed by these irregular beds that the Lower Cretaceous beds have been laid down. From their close propinquity, the sand-beds of different ages are scarcely to be defined as Oolitic or Cretaceous, and the occurrence of fossils only can secure their distinction.

At Culham, near Oxford, a clay-pit is worked, which presents at the top three feet of gravel; next about twenty feet of Gault with its peculiar fossils: then nine feet of greenish sand, with a few fossils; and lastly, twenty-three feet of Kimmeridge Clay, with its peculiar Ammonites and other fossils. The intervening sand contains *Pecten orbicularis* (a Cretaceous fossil), *Thracia depressa*, *Cardium striatulum*, and an Ammonite resembling one found in the Kimmeridge Clay. Although this sand at first sight resembles and yields a fossil found in the Lower Greensand, yet it is probably more closely related to the Kimmeridge Clay. In the railway-section at Culham, the Kimmeridge Clay is overlaid by a sand equivalent to that of Shotover Hill; whilst the Gault, which lies on it unconformably, with that of the clay-pit. At Toot Baldon also, though Lower Greensand probably caps the hill, yet an Oolitic ammonite was found on the eastward slope of the hill, in a ferruginous sand, lying conformably on the Kimmeridge Clay. From these and other instances the difficulty of mapping the country geologically may be shown to be very great.

2. "On the Association of the Lower Members of the Old Red Sandstone and the Metamorphic Rocks on the Southern Margin of the Grampians." By Prof. R. Harkness, F.R.S., F.G.S.

The area to which this paper referred is the tract lying between Stonehaven

and Strathearn, including the south-eastern flanks of the Grampians for about two-thirds of their course. Metamorphic rocks, trap-rocks, the Lower and Middle members of the Old Red Series (the former being sandstone, and the latter conglomerate), are the constituent rock-masses of the district, and give it its peculiar physical features. The mode in which these rocks are associated is well exhibited in the section on the coast (at Stonehaven), and in the several sections in the interior where streams lay bare the rocks. Sections at Stonehaven, Glenburnie, Strathfinlass, North Esk, West Water of Lithnot, Cruick Water, South Esk and Prosen, Blairgowrie, Dunkeld, Strathearn, and Glenartney, were described in detail.

Against the nearly vertical, but somewhat north-westerly dipping, metamorphic schists (which sometimes include conformable limestones), come purple flagstones, but usually separated from them by trap-rocks, having the same strike. These flagstones pitch to the south-east, but retain a high angle away from the schists, and, in many places, are intercalated with beds of trap. The lower purple flagstones are unfossiliferous; but higher up tracks of Crustaceans *(Protichnites)* have been discovered by the Rev. H. Mitchell. The grey fossiliferous flagstones of Forfarshire succeed, still with a steep dip. Conglomerates succeed, in beds having a less inclination, gradually becoming more and more horizontal as they reach the low country.

The axis of the elevation of the Grampians thus appears to be along their southern margin, and to be marked by the trap-rocks separating the metamorphic schists and the purple flagstones of the Old Red series, and giving the latter their general south-easterly dip. As the metamorphic rocks of the Grampians have not yielded any fossils, their relation to the other old rocks of Scotland is difficult to determine.

3. "On the Old Red Sandstone of the South of Scotland." By Archibald Geikie, Esq., F.G.S., of the Geological Survey of Great Britain.

This paper was the result of a series of explorations carried on at intervals from Girvan to St. Abb's Head. The first part related to the geology of the border-district of Lanark and Ayr, near Lesmahagow. The Silurians and Lower Old Red sandstones of that district, as formerly pointed out by Sir Roderick Murchison, form one consecutive series. They are traversed by great numbers of felstone-dykes, and are disposed in longitudinal folds, ranging from north-east to south-west, the Silurian strata forming the axis of each anticline. Both series are overlaid unconformably by Carboniferous strata belonging to the horizon of the Mountain Limestone group of Scotland. The features of this unconformity are well displayed all round Lesmahagow, where an enormous series of Lower Old Red sandstones, more than ten thousand feet thick, have their truncated edges overlapped by gently inclined beds of Carboniferous sandstone, shale, and limestone. The whole of the Lower Carboniferous group and the upper Old Red Sandstone, amounting in all to at least six thousand or eight thousand feet, are here wanting. But as the junction of the Carboniferous Limestone with the Lower Old Red is traced towards the east, the thickness of strata between the two formations gradually increases, until at the Pentland Hills the whole of the Lower Carboniferous series and a considerable part of the Upper Old Red have come in; and these strata, as at Lesmahagow, rest quite unconformably on the base of the Lower Old Red Sandstone and the higher beds of the Upper Silurian. Hence it becomes apparent that in the south of Scotland, as in Ireland, there is a great physical break between the Upper Old Red Sandstone and the lower part of that formation.

The author next pointed out the character of the Upper Old Red Sandstone in East Lothian and Berwickshire; showing that it graduated by imperceptible stages into the Lower Carboniferous sandstones, and formed with these one

great petralogical series. The former wide extension of the Upper Old Red Sandstone throughout the south-east of Scotland was shown by the height at which it occurs among the Lammermuirs. These hills must unquestionably have been covered by it; and hence the denudation of the south of Scotland will eventually be shown to be one of the greatest which this country has undergone. The author concluded by sketching the physical geography of South Scotland during the Upper Old Red Sandstone period, in so far as it was indicated by the facts presented in this paper. He showed that the rate of subsidence was probably much greater in the eastern than in the western districts, inasmuch as the whole of the vast series of Upper Old Red and Lower Carboniferous sandstones had accumulated in the Lothians and Berwickshire before the base of the Lesmahagow hills began to be washed by the waves of the encroaching sea.

February 1, 1860.

1. "On some Cretaceous Rocks in Jamaica." By Lucas Barrett, Esq., F.G.S., Director of the Geological Survey in Jamaica.

On the north side of Plantain-Garden river, three miles west of Bath, shale and limestone overlie conglomerate. The limestone contains *Inoceramus*, *Hippurites*, and *Nerinæa*. Higher up the river similar fossiliferous limestone occurs in vertical bands, succeeded by conglomerates, which separate it from massive porphyries.

On the medial ridge of mountains, also, at an elevation of two thousand five hundred feet above the sea, Hippurite-limestone, with black flints containing *Ventriculites*, rests on porphyry and hornblende-rock. These igneous rocks are interstratified with shales and conglomerates.

2. "On the Occurrence of a mass of Coal in the Chalk of Kent." By R. Godwin-Austen, Esq., F.G.S.

This piece of coal was met with in cutting the tunnel on the Chatham and Dover Railway, between Lydden Hill and Shepherdswell. It weighed about four hundred weight, and was four feet square, with a thickness of four inches at one part, increasing to ten inches at another. It was embedded in the chalk, where the latter was free from faults. The coal is friable, highly bituminous, and burns readily, with a peculiar smell, like that of retino-asphalt. It resembles some of the Wealden or Jurassic coals, and is unlike the true coal of the coal-measures. Mr. Godwin-Austin stated his belief that this was a block of lignite or coal of the preceding Jurassic period lifted off by ice during the Cretaceous period, and drifted away like the granitic boulder found in the Chalk at Croydon.

3. "On some Fossils from the Grey Chalk near Guildford." By R. Godwin-Austen, Esq., F.G.S.

In the cast of the body-chamber of a large *Nautilus elegans*, from the Grey Chalk of the Surrey Hills, near Guildford, the author found numerous specimens of *Aphorrais Parkinsoni*, with fragments of *Turrilites tuberculatus*, *Ammonites Coupei*, *A. varians*, and *Inoceramus concentricus*. The author believes that the specimens referred to were accumulated in the shell of the Nautilus, possibly by the animal having taken them as a meal shortly before death, at a different zone of sea-depth to that in which the Nautilus and its contents sank and became fossilized. Mr. Godwen-Austen referred to these specimens as being indicative of the contemporary formation of different deposits with their peculiar fossils, at different sea-zones; of the transport of the inhabitants of one zone to the deposits of another; and as a possible explanation of the abundance of small angular fragments of mollusks, echinoderms, and crustaceans, in the midst of the very finest Cretaceous sediment.

4. "On the Probable Events which succeeded the Close of the Cretaceous Period." By S. V. Wood, jun., Esq. Communicated by S. V. Wood, Esq., F.G.S.

The object of this paper was to show that the close of the Secondary period was followed by the formation of a continent having a great extent from east to west, and at that time chiefly occupying low latitudes; that this direction of continent prevailed throughout the Tertiary period; and that in certain portions of the southern hemisphere, particularly in Australia and New Zealand, there have been preserved portions of the Secondary continent with isolated remnants of the Secondary mammalia and gigantic birds. These conclusions were arrived at by a consideration of the direction of the principal volcanic axes in the Secondary and Tertiary periods. The Secondary continent was (the author considered) mainly influenced in the northern hemisphere by volcanic axes which came into action at the close of the Carboniferous, and continued through the Secondary Period. These axes were that of the Oural, that of the north of England prolonged into Portugal, and that of the Alleghanies, having all a north and south direction, supervening upon volcanic axes having a direction at right angles to them, which had prevailed during the Newer Palæozoic period. From this circumstance an inference was drawn that the Secondary continents had generally a trend from north to south, governed by volcanic bands having this direction; while, as the Secondary formations indicate a great extent of sea over the northern hemisphere, the bulk of the Secondary continent lay in the southern hemisphere.

The elevation of the bed of the Cretaceous sea, it was inferred, was due to volcanic forces acting from east to west; and the author adduced evidence of this action having become perceptible during the later part of the Cretaceous period. He considered that the direction of all the Post-cretaceous lines of volcanic action governed the direction of the continent during the Post-cretaceous period, and pointed out that these were all in an easterly and westerly direction, coincident with the existing volcanic band which extends from the Azores to the Caspian, and thence (with an interval of intense earthquake action between the Caspian and Bengal) extends to the Society Isles. He concluded that they gave rise to a continent extending from the Carribbean Sea to the Society Isles—many reasons uniting to show a land-connexion between America and Europe at the dawn of the Tertiary period, the submerged continent of Oceanica also indicating the easterly extension of Southern Asia; and that, since this continent receded to the north at the dawn of the Tertiary period before the inroad of the Nummulitic Sea (which stretched from the south-east through Western Asia and Southern Europe, and was, as the author conceives, the oceanic equivalent of the Eocene basins of Europe) the greater portion of the deposits formed in the interval between Cretaceous and Eocene times must be now under the Southern Oceans.

The author then adverted to the circumstance that the recent great wingless birds and the nearest living affinities of all the Secondary mammalia yet known occur only in the southern hemisphere. From this, and from some considerations as to the vegetation, he concluded that, while parts of the Secondary continent yet remain in that hemisphere incorporated more or less into the Post-cretaceous continent, other parts of it, such as Australia and New Zealand, have remained isolated up to the present time to an extent sufficient to preclude the migration of mammalia and wingless birds. He inferred that the wingless birds, excepting the swift Struthionidæ, have been preserved solely by isolation from the carnivora, which do not appear as an important family until the Pliocene age; and he instanced the Gastrornis of the Eocene (which had affinities with the Solitaire and Notornis) as evidence that the apterous birds had survived until that period.

An inference was then drawn that the remains of the Secondary continent, accumulated to the southward, caused cold currents to flow to the southern shores of the Post-cretaceous continent, causing the extinction of the bottom-feeding and shore-following Tetrabranchiata, to which Mr. Wood attributes the destruction of the Cestracionts which fed on them, and that of the marine Saurians that fed on the Cestracionts. The preservation of the Dibranchiata, on the contrary, was attributed to their being ocean-rangers. The extinction of the Megalosauria he attributed to the effect produced on vegetation by the alternation of dry seasons during the year, brought about by a great equatorial extent of land—the extinction of the herbivorous Megalosauria, by this cause, involving that of the carnivorous.

The author also alluded to the contiguity of volcanos to the seas or great waters, which he considered to admit of explanation by every volcanic elevation causing a corresponding and contiguous depression, which either brings the sea or collects the land-drainage into contiguity with the volcanic region; and in conclusion he alluded to the law of natural selection and correlation of growth lately advanced by Mr. Darwin, in the soundess of which he asserted his belief.

February 15, 1860.

1. "On the Probable Glacial Origin of some Norwegian Lakes." By T. Codrington, Esq., F.G.S.

The lakes referred to were those frequently found situated at a short distance from the head of the several fjords on the western coast of Norway. The fjord and the valley in which such a lake or "vand" lies are parts of one great chasm, with perpendicular sides, often thousands of feet high. The valley generally shows traces of the former existence of a glacier, and is now traversed by a rapid river, which falls into a vand or lake six or seven miles long, rarely a mile wide, and very deep. The lake is separated from the fjord by a mass of rolled stones, shingle, and coarse sand roughly stratified, and sometimes rising one hundred and twenty feet above the lake. Through this an outlet has been cut to the fjord, a distance varying from about one to four miles. On the side towards the lake this mound is terraced; and at the upper end of the lake similar terraces are sometimes seen. The author, with some doubt, attributes the accumulation of this terraced barrier to glacial action.

2. On the Drift and Gravels of the North of Scotland." By T. F. Jamieson, Esq. Communicated by Sir R. I. Murchison, F.G.S.

In a former communication the author gave an account of some features of the Pleistocene deposits along the coast of Aberdeenshire, showing that in certain localities remains of marine animals occur, of a character similar to those met with in the later Tertiary beds of the Clyde district, and, like them, indicating the presence of a colder sea. In the present paper the author treated of the Drift of the higher grounds in the interior of the country, more especially as regards that part of Scotland lying between the Moray Firth and the Firth of Tay. The following phenomena were more particularly described:—1. The upper gravels, their distribution and origin; 2. the marine drift of the higher grounds and of the highland glens; 3. the striated and polished rock-surfaces beneath the Drift; 4. the high-lying boulders, and the dispersion of blocks from the Ben Muic Dhui Mountains. The probability of extensive glacier-action before the formation of the Drift, the extinction of the land-fauna preceding the Drift, and the sequence of events during the Pleistocene period were then dwelt upon; and the author expressed his opinion that the following course of events may be supposed to have occurred in the Pleistocene history of Scotland. 1st. A period when the country stood as high as, or probably higher than at present, with an extensive development of glaciers and land-ice,

which polished and striated the subjacent rocks, transported many of the erratic blocks, destroyed the pre-existing alluvium, and left much boulder-earth in various places. 2ndly. To this succeeded a period of submergence, when the sea gradually advanced until almost the whole country was covered. This was the time of the marine drift with floating ice. The beds with arctic shells belonged to it, and some of the brick-clays are probably but the fine mud of the deeper parts of the same sea-bottom. 3rdly. The land emerged from the water, during which emergence the preceding drift-beds suffered much denudation, giving rise to the extensive superficial accumulations of water-rolled gravel that now overspread much of the surface. This movement continued until the land obtained a higher position than it now has, and became connected with the continent of Europe. Its various islands were probably also more or less in conjunction. The present assemblage of animals and plants gradually migrated hither from adjoining lands. Glaciers may have still been formed in favourable places, but probably never regained the former extension. 4thly. The land sank again until the sea in most places reached a height of from thirty to forty feet above the present tide-mark. Patches of forest-ground were submerged along the coast. The clays and beds of silt, forming the "carses" of the Forth, Tay, and other rivers, were accumulated, as well as the post-tertiary beds of the Clyde, &c., described by Mr. James Smith, the shells of which agree with those of our present seas. 5thly. An elevation at length took place, by which the land attained its present level. As Mr. Smith has shown, this probably occurred before the Roman invasion; but that man had previously got into the country appears from the fact that the elevated beds of silt near Glasgow contain overturned and swamped canoes with stone implements.

March, 14, 1860.—L. Horner, Esq., President, in the Chair.

The following communications were read :—

1. "On the Occurrence of *Lingula Credneri* in the Coal-measures of Durham." By J. W. Kirkby, Esq. Communicated by T. Davidson, Esq., F.G.S.

As the *Lingula Credneri* of Geinitz, formerly known only in the Permian rocks (Lower Permian of Germany; Marlslate of Durham and Northumberland), has of late been found by Mr. Kirkby in the Coal-measures at the Ryhope Winning, near Sunderland, he offers this notice as of interest both as to the discovery of another species common to the faunæ of the Carboniferous and Permian eras, and as illustrative of some of the physical conditions which obtained during the deposition of the Upper Coal-measures of the North of England, the occasional occurrence of this *Lingula* proving that marine conditions prevailed at intervals in the Durham area during the accumulation of those deposits.

The species now known to be common to the Carboniferous and Permian faunæ (besides *L. Credneri*) are *Terebratula Saccalus*, Mart. (*T. sufflata*, Schl.), *Spirifera Urii*, Flem. (*Martinia Clannyana*, King), *Spiriferina costata*, Schl. (*Sp. octoplicata*, Sow.), *Camarophoria Crumena*, Mart. (*Terebratula Schlotheimii*, V. Buch.), *Camarophoria globulina*, Phil. (*Terebratula rhomboidea*, Phil.),—on the authority of Mr. Davidson; *Cythere elongata*, Münst., *C. inornata*, M'Coy, *Bairdia gracilis*, M'Coy,—on the authority of Mr. Rupert Jones; *Gyracanthus formosus*, Ag.—according to Messrs. King and Howse; *Pinites Brandlingi*, Lindl., *Trigonocarpon*, *Noeggerathi*, Brong., *Sigillaria reniformis*, Brong., *Calamites approximatus*, Brong., and *C. inæqualis* (?), Brong.,—collected by Mr. Howse in the lowest Permian sandstone. From the preceding list of Carboniferous species found also in the Permian strata of Durham, we are able (says

the author) to see at a glance the specific relationship (so far as at present known) which exists between the life-groups of the later palæozoic periods. The generic affinity of these groups has long been noticed. This affinity and other apparent indications of a want of systematic difference originated the proposal that the Permian should be included in the Carboniferous system; and Mr. Kirkby considers that the existence of the several recurrent Carboniferous species in the Permian rocks strongly supports this view, and that "Permian" should be retained only as a subordinate term.

2. "On the Rocks, Ores, and other Minerals on the property of the Marquis of Breadalbane in the Highlands of Scotland." By C. H. G. Thost, Esq. Communicated by Prof. J. Nicol, F.G.S.

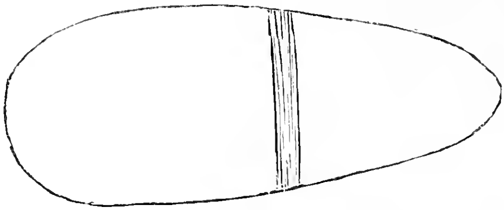
After noticing generally the mica-schists of the district, with its limestone or calcareous schist, and occasional roofing-slate, the author proceeded to describe first the porphyry-vein (half a mile wide), containing silver-ore, copper-pyrites, grey copper-ore, iron-pyrites, and molybdena, and crossing a vein of non-metalliferous greenstone, at Tomnadasham, on Loch Tay, opposite Ben Lawers. He then pointed out the probable connection of the existing great valleys with lines of fracture due to igneous violence. The veins at Ardtallanaig, containing heavy spar, and ores of zinc, copper, and iron, were next noticed. At Correbuich there are two sets of veins in the calcareous schist; those having a north and south direction contain argentiferous galena and traces of gold. The most eastern hills on Loch Tay, in the neighbourhood of Taymouth, abound with quartzose veins containing copper-pyrites, iron-pyrites, and galena. The iron-ore of Glenqueich, and the serpentine and chromate of iron at Corycharmaig, where graphite and rutile also occur, were next noticed. At Lochearn Head there are galena-veins in calcareous schist; here, too, some auriferous arsenical pyrites has been found. Lastly the author described in some detail the lead-bearing veins of Glen Fallich and Tyndrum, which have been worked for many years.

NOTES AND QUERIES.

Hammers of Stone and Flint.—The daily discoveries of implements of flint and stone throughout Yorkshire and other counties in England have often caused people to wonder and ask the same questions which are made by "Inquirer" in your "Geologist" of last month; and having been for several years a collector and storer of implements of flint and stones, you will perhaps allow me through your pages to make as concisely as possible a few remarks on the hammers in my own collection, and in the public collections in London, Dublin, and Edinburgh, from which I have no doubt "Inquirer" and others may draw conclusions of such a nature as will satisfy their curiosity, enlighten their understanding, and give pleasure to all who make matters of this description their study. In a magazine devoted to a science of so much importance as Geology, it cannot be expected that you can devote so much space to remarks which have not a direct bearing on the subjects to which your pages are generally dedicated; but the finding of so many implements of stone and flint at great depths below the surface of the earth, which have been made by human beings, having created a great amount of interest, I may perhaps trespass more on your space than I otherwise should have done.

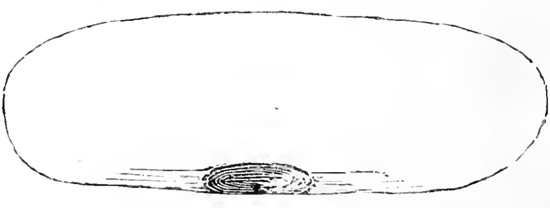
In the collections mentioned there are a great quantity of hammers; upwards

of seventy. Their shapes vary considerably, and no doubt they were made for various special purposes. One of the hammers in my collection has been so well preserved deep in the earth (overlying the chalk in the township of Bridlington) that it shows the mode in which it was made. It is five and three-quarter inches long, two and a-quarter wide, and about five inches in circumference; an oblong oval, inclined to be flattened on the sides. Along and across the whole of the exterior it shows the indentations and lines of shaping by the tool with which it was made. It has no hole to hold a shaft. The form of this hammer is, as before stated, oblong, and tapering towards one end of it, as are some of the tools or weapons called "celts."



Lign. 1.—Sandstone hammer with groove.

The outlines of the hammer in question are as above. The mode in which the handle was fastened to this instrument was no doubt by having a pliable stick wound round the smaller end, and the two ends brought into juxtaposition and tied fast together, as a smith fastens a rod round the chisel with which he cuts hot iron. It will be seen at a glance that when the instrument was thus fastened, and the thick end was struck against any object, that the wedge-like form of the hammer would no doubt cause it to be held tight, and the oftener it was used the tighter it would be held, by the mode used in fastening it. This hammer is of sandstone, of a rather fine grain.



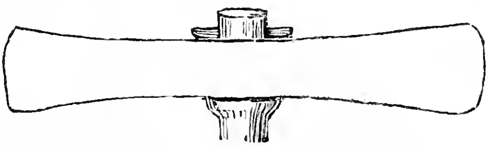
Lign. 2.—Sandstone hammer with drilled hole.

Another hammer in my collection, made of sandstone, having a hole in it for a handle, and is made in shape somewhat like the sketch (Fig. 2). The hole is deeply splayed, and was no doubt made by rotatory friction, as rubbing with another harder stone and the use of sand and water; yet as the stone hammer descended to much more modern times than weapons of the same material, metal may have been employed in making the aperture.

Several examples of hammers having the holes for the handle made by a metal drill have come before my notice; and others are mentioned at page 78 of the Catalogue of the Museum of the Royal Irish Academy, which museum contains the greatest quantity of implements in stone and flint of any public

collection in the United Kingdom, but not by any means so great a variety as my own museum.

Where metal was used in making holes in hammers, the sides of the apertures are cylindrical, and in some cases the circular lines left by the tool may be seen. There are many instances of this in the hammer-heads in the Museum of the Royal Irish Academy. Where, on the contrary, a stone, with sand and water was used, the edges of the aperture are deeply splayed on each side, and the septum broken through, as shown in some of my examples, as also in a number both in the Dublin and Edinburgh Museums. From examination of the several specimens I come to the conclusion that in the earliest and rudest the position chosen for the hole was first chipped or punched into a hollow, or indentation, and then by the process of a rotatory or grinding action with a hard stone adapted for the purpose, and sand and water. One half of the work of making the hole being thus accomplished, by the like process the opposite side of the hammer was worked out until in the centre or near it the apertures met. The commencement of this process may be seen in several ovoid-shaped stones, and a series of objects illustrating the process of the formation.



Lign. 3.—Stone hammer with complete perforation.

The third hammer in my collection is one made of granite of a form quite uncommon, great pains having also been taken in its manufacture. It is ground all over its external surface, and partakes of the axe and hammer in shape, the hole in its centre being ground, and, from appearances, it was put upon a shaft, the small end of which passed through the top of the hammer, and a pin was driven through the shaft, and it was thus fastened to the handle; the under side of the hammer rested on a thicker or collar part of the handle, left wide to allow the under side of the hammer to rest upon it. I give you a sketch of this hammer from a drawing taken some time ago. Much more might be said about such implements had I time, for want of which I conclude these remarks by stating that the hammers were made by chipping, boring, drilling, and rubbing, and the first hammers could be made *without the use of metal.*

Metal might be known but yet not worked for or into hammers. Finally I would observe that hammers are made of almost all the hard stones that are found in England; but it is not my intention to describe their lithological characters, but simply to state that the rudest of them are frequently made of softer stone, and that those which were intended for special purposes were made in a careful manner, highly wrought, and of more durable material.—EDWARD TINDALL, Bridlington.

THE GREAT MONOLITHS AT BOROUGHBRIDGE.—SIR,—Having had occasion to visit Boroughbridge during the time of the last Barnaby Fair—so named in consequence of its occurring each year on the day of St. Barnabas, I took the opportunity of examining the extraordinary monoliths, better known to the people at the old borough and vicinity as the "Devil's Arrows." As these remarkable obelisks are spoken of by almost all topographers, antiquarians, and geologists, I think it will not be out of place to hand you a brief description of them and of the observations made by me.

The stones at present standing are three in number. The first, or the one

which bears most towards the north, measures twenty-five feet five inches, the second measures seventeen feet three inches, the third, or that stone which stands most towards the south, has a measurement of fifteen feet eight inches in circumference. The measurements were made with a tape four feet from the surface, taken as accurately as possible. Their sides partake rather of a convex form. The sides of the first monolith measured seven and a-half feet by four feet three inches, the second four feet three inches by four feet five inches, and the third four feet eight inches by four feet; but these side measurements are only approximate, their sides being so uneven and irregular it is difficult to obtain measurements with any degree of accuracy, hence, to take the whole girt at once is the best means. Their altitudes I had not the requisites with me for ascertaining; however, according to Gough, as quoted by Professor Phillips, in his "Rivers, Mountains, and Sea-coast of Yorkshire" (page 67, second edition), "The northern stone is sixteen and a-half feet by eighty-four inches, the middle one twenty-one and a-half feet by fifty-five and a-quarter inches, and the southern one twenty-two and a-half by four at four and a-half feet above the ground." The distance of the exterior monoliths is respectively sixty-two yards, and one hundred and twelve yards from that which is in the interior. The middle antiquital relic, as I may justly term it, stands four yards to the west out of a straight line with the other two. The first which we took dimensions of has the greatest girt, but is lowest in stature, due, no doubt, to having had a portion of its top broken off at an early period. The second and third monoliths, as may be perceived by the figures of Gough, are much taller, and lean in a southerly direction nearly a foot from the perpendicular; hence it is we come to the conclusion that it will not at all be unphilosophical to attribute their leaning attitudes to the effect of tempestuous winds, which may have blown athwart the island from the contrary direction during the last two thousand years, during which time they may have stood. The lowest monolith does not lean, but occupies a perpendicular position, although, as its side measures seven and a-half feet, or three and a-half feet more in breadth than either of the others, consequently it must be confessed the winds must have had a broader face to infringe against. We might, however, explain why this monolith stands erect, and why the other two partake of a leaning appearance, by taking into consideration the possibility of the top to have been broken off either at the time of its erection or at a very early period. Professor Phillips, in speaking of these great wonders in the work referred to, says, "They have doubtless been extracted from the great rocks of Brimham or Plumpton." They are not made or built up out of many stones cemented together, but each monolith consists of one entire mass of the same stone as the millstone-grit of geologists. These pyramids are fluted or groined downwards, not by the hand of art, but by the pelting rains which have fallen upon their apices for centuries. Leland, an antiquary of the time of Henry VIII., makes mention of four. Cambden, immediately following, speaks of three, the other having been thrown down by "the accursed love of gain" (Phillips, page 66). Some writers imagine the stones to be trophies of victory. Others affirm that each was erected in honour and commemoration of one of the Roman emperors; others to the Druids. From what we are able to gather from history, the Brigantes who lived in Yorkshire and the northern part of England, when Druidism was in great glory, were a wild people, and lived in habitations made from trees, and interwoven with branches, wearing for their clothing the skins of animals, and lived chiefly by hunting. Their religion was chiefly Druidical, as then prevalent in all parts of the island. They, too, studied medicine, considered the mistletoe as their chief specific, and held the mistletoe of the oak with great solemnity, which, being very scarce, they gathered with great pomp and ceremony on a certain day appointed for the great festival. They

are said to have met here to celebrate their great quaternal sacrifice; and as Aldborough, another place nearly a mile from Boroughbridge, was the capital Isurian of the Brigantes, it is not at all improbable to suppose that the largest mark of an holy edifice would be established here for the large quaternal religious gathering.

Their name, as the Devil's Arrows, seems to have originated from the following story, which we had related to us by an hoary headed individual living in Boroughbridge, when soliciting information as to their history:

"There lived a very pious old man [a Druid should we imagine] who was reckoned an excellent cultivator of the soil. However, during each season at the time his crops had come to maturity they were woefully pillaged by his surrounding neighbours; so that at this, he being provokingly grieved, the Devil appeared, telling the old man if he would only recant and throw away his holiness he should never more be disturbed in his mind, or have whatever he grew stolen or demolished. The old man, like Eve in the garden, yielded to temptation, and at once obeyed the impulse of Satan for the benefit of worldly gain. So when the old man's crops were again being pillaged, the Devil threw from the infernal regions some ponderous arrows, which so frightened the plunderers by shaking the earth that never more was he harrassed in that way. Hence the name of the "Devil's Arrows."

Another individual told me it was believed by some that the stones sprung up one night in the very places they now occupy. These opinions seem to be somewhat firmly fixed in the minds of the narrators. A superstition once imbibed is in many instances difficult to eradicate. However, we neither believe nor wish others to believe that they either sprung up in a single night, or were shot from a bow of Satan. Having examined and procured all information we possibly could respecting the monoliths at Boroughbridge, we next proceeded to Aldborough, a most pleasing walk of nearly a mile. We were kindly conducted and shown through the gardens of A. S. Lawson, Esq. In these gardens are many antiquities of different descriptions, both of the Brigantes and Romans, but especially of the latter. The late Mr. Lawson excavated and laid open for several yards the wall which surrounded the capital of the Romans. Whilst laying bare this portion of wall—which may be seen through the hospitality of Mr. Lawson—coins, &c., were found, all of which are carefully deposited in this gentleman's museum. Several tessellated pavements are most beautifully exposed and preserved in different parts of the village, and which may be seen for a trifling fee. There lies two splendid pavements beneath the floor of Mr. Lawson's Museum. Within the gardens a hot bath and a cold bath of Roman workmanship are to be seen.

The wall, built by the Romans, measures two and a-half yards in thickness; the material is red sandstone. A splendid section of this red sandstone may be seen in a pit behind the southern part of the gardens.

As the Romans had their capital here after the Brigantes were routed, it might be conjectured that the monoliths at Boroughbridge are erections of the Romans. However, from the researches of the Messrs. Lawson, no doubt but the question may be fairly settled as to their origin.

Now taking leave of the quaint old city, with many a curious thought treasured up in my memory, I took train viâ Pillmoor to Easingwold, not with the expectation of seeing such wonders as I had just left, but rather as a flying visit to see an old acquaintance. However, being of an inquisitive turn of mind, I began asking if there were any things wonderful in Easingwold or its vicinity, and I soon found that a Mr. Nicholson, in the spring of 1858 or 1859 had bored to a considerable depth in the hope of finding coal, but, alas, all his labour ended in "smoke;" none could be found. On making further inquiries, and on examination of the district, there appeared great judgment on Mr.

Nicholson's part for attempting to bore for the precious fuel; but whether this gentleman had not gone low enough, or that the coal-seams had cropped or thinned out here, in their direction from the north, we cannot say.

We next were invited to cast our eyes to Hambleton Hill, then we should behold an object called the "White Mare." Scarcely knowing the meaning of this phrase, but doing as requested, we were astonished to observe at a distance of twelve or fifteen miles a faithful representation of a white horse shaped out of the rock on the steep hill of Hambleton. This large hieroglyphic, the size of which I do not at present know, was executed a few years ago through the instrumentality of a party of gentlemen, as I understood, who came from York. This object is a great curiosity, and may be seen at the station at Pilmoor by travellers along the Malton and Thirsk railway.—Yours truly, ROBT. MORTIMER, Fimber, Malton.

GEOLOGY OF READING.—DEAR SIR,—Your correspondent, A. H., should get Mr. Prestwich's pamphlet, "The Ground Beneath Us," Van Voorst, London, 1857, for a general account of the Lower Tertiary beds and the gravels. For a special account of the geology of the neighbourhood of Reading, I beg to refer him to the recently published Geological Survey Map of that part (sheet 13), and to a memoir, now in the press, illustrating that map. The following information may be useful to your correspondent:

The beds in the neighbourhood of Reading are, in ascending order, Upper Chalk (with flints), Woolwich and Reading beds (the Thanet sands being absent), London Clay, and Drift-gravel.

No doubt fossils may be got in many of the chalk-pits, but I did not look for them myself. In the railway-cutting at Pangbourn the characteristic fossils of the Chalk occur, and in a chalk-pit by the river side a small reversed fault may be seen.

The Woolwich and Reading beds are almost unfossiliferous in the western part of the London basin. The "bottom-bed" of this formation, however, contains in this neighbourhood a few fossils in the state of casts, besides the well-known "oyster-bed" that generally occurs immediately above the Chalk. The "bottom-bed" consists of roughly-laminated dark grey clay and clayey sand, generally with green grains—often, indeed, being a regular greensand. The only place that I know of where this bed is now to be seen at Reading is at Castle Kiln, where there is the following general section:—

Plastic clays and sands of the Woolwich and Reading beds, over thirty feet.

Bottom-bed of the Woolwich and Reading beds, over four feet.

Chalk, with fossils.

In the bottom-bed here the following fossils were found by Mr. Gibbs, the fossil-collector of the Survey, and myself: Fish-teeth, *Arca*, *Nucula*, *Cardium Laytoni*, *Cyrena tellinella*, *Psammobia*?, and a small *Bryozoan*. All were casts, rather imperfect, and, though tolerably plentiful, not to be found without a little practice. The bed of oyster-shells I did not find here; but there are most likely casts of oyster-shells in the bottom-bed; neither was the uppermost part of the Chalk riddled with the network of tubular cavities (made by boring molluscs) so often to be seen in it where capped by the "bottom-bed."

In a brick-yard about half a mile to the north-east of Theale the "bottom-bed" may again be seen; here it is thicker, and also contains casts of shells. Various species of oysters are the only fossils hitherto published as found in these beds in this district. I believe that the officers of the Geological Survey were the first to find any others.

There are sections of the "basement-bed" of the London Clay at Katesgrove Kiln (at the top of the section), and at the brick-yard about half a mile to the north-west of Upper Early; and when I was first at Reading it might be seen at the brick-yard near Redlands. It has been found at some depth at

the kilns above Caversham, where there are lying about many blocks of limestone from it, which are very full of fossils. This "basement-bed" is a loam, or sandy clay, of a general dull brown colour, with occasional seams of greensand containing shells in a very perfect state, until one attempts to get them out; flint-pebbles, often in beds, ironstone-nodules, and masses of limestone are of frequent occurrence. The limestone is very often nothing but a mass of fossils, generally the *Ditrupa plana*. The following fossils have been found in the "basement-bed" at the various places above-noted.:—*Natica glaucinoides*, n. sp., *Calyptræa trochiformis*, *Fusus*, *Pleurotoma*, *Scalaria*, *Pectunculus brevirostris*, *Cytherea obliqua*, *Cardium nitens*, *C. Plumsteadiense*, *C.* sp., *Pinna*, *Modiola elegans*, Oyster, *Ditrupa plana*, and *Cancellaria* (?). Of the London Clay itself I do not remember any good sections.

The low-level-gravel is thick and plentiful near Reading, far too much so indeed to suit a field-geologist, as it hides other beds, and makes their boundaries doubtful. Mammalian remains may pernaps be found in it, as they have been in the same bed near Maidenhead and at Hurley, near Great Marlow. It is made up almost wholly of flints, chiefly sub-angular fragments, but partly in the state of rounded pebbles; the latter derived from the wearing away of older Tertiary beds.

A more detailed account of the sections here noticed, and of some others in the neighbourhood, will be found in the above-mentioned memoir, which will be published very shortly.—I am, yours truly, WILLIAM WHITAKER.

P.S. Since writing the above I have had occasion to spend a couple of days at Reading, and I then noticed a section of the basement-bed of the London Clay, at the kiln at Woolwich Green, nearly a mile to the south of Theale station. The section is chiefly in the London Clay itself; but at the northern end the "basement-bed" has been cut into. Not much more than a foot of it is now to be seen; but in that small thickness there are two or three beds of fossils, in which I noticed at least fifteen species. In the course of a few weeks, when this bed will be cut further back, I should think that, with care, many good fossils might be got from it.—W. W.

AGE OF THE WEXFORD SCHISTS, &c.—DEAR SIR,—Will you be so kind as to oblige me by inserting in your next publication, and by way of adjunct to my paper which appeared in the "GEOLOGIST" of February last, that I consider the Wexford schists, slates, and grits, composing the coast-line from Dollar Bay in the south to Arthurstown or Kingsbay in the north, as identical with the Longmynd or Cambrian rocks of Wales; and that the Llandeilo beds at Duncannon referred to in my former observations lie in a trough or depression among the more ancient deposits.

About twenty years since I obtained one species of *Oldhamia* and *Arenicolites* from the district now referred to—near Aldridge Bay, in the county of Wexford. This I showed to officers employed on the government survey and to other geologists; but the specimens which I had procured after a laborious research were regarded as not exhibiting sufficient organic structure to allow of their being admitted on the list of fossils found in the United Kingdom.

I now make known my claim as to being the first to record the fact of the existence of Longmynd or Bottom-rocks in the county of Wexford. I laboured for several years among those old rocks, breaking stratum after stratum for many miles, therefore feel much interest in everything relating to their history. —Dear sir, yours truly, THOMAS AUSTIN.

LAMELLAR STRUCTURE OF ROCKS.—SIR,—I would feel obliged if you could give any information respecting the lamellar condition of rocks long subject to the action of the waves? Balls of earth exposed to them soon become hardened into concentric layers; and many large boulders are to be seen on the shores here whose centres are perfectly compact and as hard as granite, the influence of the sea in crystallizing and moulding them being quite visible

in the outer concentric laminated layers of still unhardened mud encircling them. I can bring evidence to show that this is no effect of disintegration; and I am anxious to know how far the laws respecting chemical segregation under conditions such as described are ascertained, or if any relation can be traced between such facts and the well-known phenomena of slaty cleavage—the twisting, as it were, of gneiss round the granitic centres of mountains, and the contortions in various rocks hitherto erroneously ascribed to violent squeezing, &c. The manner in which water enters and leaves a given substance may ultimately produce a change of form, just as electric currents passed through iron render it different from its former state. I have observed that where the substance acted upon is a stationary mass of mud or sand, the layers all follow one direction, until we come to a sort of axis, as it were, and there the direction of the laminæ become reversed.

Now if the crystalline arrangement of bodies depend upon the weight of their atoms, and that the medium in which they are placed, as well as the motions to which they are subjected must be studied to produce artificial crystals, why should chemists not be able to elucidate the laws by which large masses not only have an internal minute crystalline structure, but also a regular geometric arrangement into larger squares or circles, both these effects being produced by the force of gravitation. Were it proved that the lamellar structure of rocks owes its origin to water, it would be an additional evidence that granitic rocks are in reality not of igneous origin.—Yours, &c., A., Belfast.

Manufacture of Stone Implements.—Sir,—The stone axes such as your "Inquirer" describes having doubtless excited much interesting speculation, it is to be hoped your next number will contain replies to some of his queries regarding implements which seem to have been manufactured by people singularly endowed with the virtue called patience. Perhaps the author of the paper on the "Giant's Causeway," which appeared some time ago in your magazine, being an antiquarian as well as a geologist, would give some suggestions regarding their manufacture?

I have seen one, belonging to Lord Talbot de Malahide, the careful workmanship and high finish of which might well call forth similar inquiries to those of your correspondent. It was, as nearly as I can recollect, formed of basalt also; and being so well finished suggested the use of a metal in its manufacture, which, however, may have been too scarce to have superseded the use of stone-weapons.

Stones along a sea-beach are often perforated by marine creatures, so that handles could easily be adapted to them, but then they are always composed of limestone, a rock which I have never known to be used for these stone axes.—A. B. W., F.G.S. Sept. 8th, 1860.

Lias at Whitchurch.—Sir,—In the geological map that accompanies the last edition (the 3rd) of Sir R. Murchison's "Siluria" I observe a patch of Lias marked as occurring between Whitchurch and Market Drayton.

I should be glad to know whether on that patch there be any accessible sections whence might be procured specimens of the very interesting fossils of the Lias formation. Being a new comer to the neighbourhood, and moreover a very tyro in geological studies, I, on both these grounds, stand in need of a little help in the way of information.—Faithfully yours, Omega.

P.S. Are there any geologists in this locality or neighbourhood?

Fish from the Coal-Measures.—Sir,—You will oblige me by informing me in your next number which is the best work that treats of the fish of the Coal-measures next to Agassiz's "Poissons Fossiles."—Subscriber.

The fossil fish of the Carboniferous rocks are not yet fully described. Beyond some scattered notices by Egerton (in the Geol. Quart. Jour.) and others, there are no other descriptions except those in Agassiz's great work.

THE GEOLOGIST.

NOVEMBER, 1860.

GEOLOGICAL LOCALITIES.—No. I.

FOLKESTONE.

By S. J. Mackie, F.G.S., F.S.A.

(*Continued from page* 357.)

Rosinus, Walch, Lemery, and others writing after him followed not in the new path opened out to them, but reiterated former absurdities.

Bruckmann thinks them a kind of pholas, or boring shell; Bourquet holds to the old notion of their being teeth of whales; Klein even in 1731 regards them as worm-tubes, although three years later he comes round to the opinion that they were nearly allied to the Argonautes, Spirulæ, and chambered shells. Dufay, one of the numerous writers who followed, states that burnt belemnites have the property of being luminous after having been calcined upwards of five years. We have not tried the experiment, and cannot, therefore, speak to the accuracy of the assertion.

Capeller, in 1740, proposes to regard the Belemnite as a species of Holothuria, the soft parts of which had become petrified; the opening, in his opinion, being the mouth of the creature for seizing its prey, and the alveolus a shell half swallowed.

Bromell, Ritter (1741), Da Costa (1747), lead up to Linnæus, who in his "Systema Natura" has placed them somewhere near the mark. Of the authors which now follow, Baker (1748) regarded them as marine animals allied to Orthoceras; Stobæus (1752), as a species of

coral; Brander (1754), as species of Argonauts, allied to Orthoceras, the young being without cavities, the adults having alveoli. Allioni (1757) says "Targionio Toggeto speaks in his voyages of having seen a living Belemnite attached to red coral in the cabinet of Vincent Capponi;" but travellers, we know, tell strange tales, and they have told marvellous ones in respect to the cuttle-fish. Denys Montfort represented a "kraken octopod" scutling a "three-masted" ship; and is said to have told Defrance that if this were "swallowed," he would in his next edition represent the monster embracing the Straits of Gibraltar, or capsizing a squadron.

From Wallerius, Jean Gesner, Torrubia, Cartheuser (1755), D'Argenville, Walch, Viallet (1761), Bertrand (1763), we get no new notions; while we are favoured with the following from Le Monnier—of their being polypes, composed of osseous articulations, living in the end of the shell; from Titius of their being the claws or nails of cartilaginous star-fish, by means of which they crawled along in the sea.

Joshua Platt, in 1764, however, makes another step. Agreeing with Ehrhart generally, he confirms his idea of the mode of growth by supposing it to have been accomplished by the two lobes of the mantle of the animal, after the manner of the shells of the Porcellaines.

Again passing over in the long list of authors the names of Rosinus (1767), Andræa, Duluc (1765), Tressau, Firmin (1767, who pretends to have found a living analogue, but really only a mutilated calmar), Pallas (in the "Magasin de Stralsund), Walch (1775, in Knorr's great work on fossils), Guettard (1783, by whom considered as a straight nautilus), we come to the nineteenth century, when another step was made towards more correct knowledge by the investigations which then began for the purpose of ascertaing the *position* of the Belemnite in the body of the animal. M. de Blainville figures most conspicuously in the list of authors of this period, amongst which may be mentioned Sage, Deluc, Denys de Montfort (1808), Defrance (who had the happy idea of separating the species of Belemnites into those anterior to the Chalk Period, and those belonging to it); Beudant, who showed the limitation of the range of rocks in which they occurred; Faure Biquet, who distinguished several species; Cuvier

and Lamark, who of course classed them with the cephalopods; Parkinson, who considered their spathose structure as due to fossilization; Schlotheim, Ferussac (1822) and J. S. Miller, who in 1823 read a paper before the Geological Society of London, specifying the nature of the Belemnite and its position in the animal, considering it analogous to the bone of the sepia, but according that priority of information which was due to M. de Blainville.

We now hand our readers a list of the classification of the cephalopods, and shall then proceed to describe more particularly the natural characters of the divisions which are essential for a proper knowledge of the beautiful fossil forms of the Gault.

CLASS, CEPHALOPODA.

Order I.—DIBRANCHIATA = ACETABULIFERA.

Section I.—OCTOPODA = 8 arms.

Family 1. *Argonautidæ.*
2. *Octopodidæ.*

Section II.—DECAPODA.

3. *Teuthidæ.*
4. *Belemnites.*
5. *Sepiadæ.*
6. *Spirulidæ.*

Order II.—TETRABRANCHIATA = TENTACULIFERA.

Section I.—NAUTILI.

Family 1. *Nautilidæ.*
2. *Orthoceratidæ.*

Section II.—AMMONITES.

3. *Ammonitidæ.*

Where the ornamentation of a class of shells is so various and intricate as in the Ammonites, it becomes necessary to classify, as far as possible, the general characters of the *kinds* of patterns or methods on which the ornamentations are based. In the Ammonites these variations are at once apparent and distinct; we see some with keels; some with channels, or furrows along the back; some with the backs square; some round; some sharp and others crenated; and these again in varied stages, and susceptible again of minor divisions. Quenstedt, whose work is generally taken as the basis of the classification of the Ammonites, has thus divided them—an arrangement which has been adopted by Mr. S. P. Woodward.

AMMONITES.

Section I.—Back with entire keel.

1. *Arietes* (ram-horn).
2. *Falciferi* (sickle-bearing).
3. *Cristati* (crested).

Section II.—Back crenated.

4. *Amalthei.*
5. *Rhotomagenses.*

Section III.—Back sharp.

6. *Disci* (quoit-shape).

Section IV.—Back channelled.

7. *Dentati* (toothed).

Section V.—Back squared.

8. *Armati* (armed).
9. *Capricorni* (gort-horn).
10. *Ornati* (ornamented).

Section VI.—Back round, = convex.

11. *Heterophylli* (odd-leaf).
12. *Ligati* (constricted).
13. *Annulati* (ringed).
14. *Coronati* (coronate).
15. *Fimbriati* (bordered).
16. *Cassiani* [complex lobes].

(To be continued.)

RESEARCHES ON PSEUDOMORPHS.

By M. Delesse.

Translated from the "Annales des Mines"* by H. C. Salmon, F.G.S.

Metamorphism, considered in its widest generality, comprises all the modifications which mineral substances undergo. It is naturally divisible into parts, according as its objects bear upon minerals or upon rocks. It is the metamorphism of minerals which I propose studying in this notice, and I shall describe it under the name of pseudomorphism. But as certain associations of minerals present all the appearances of pseudomorphism, with which they have been often confounded, it is necessary, in the first place, to consider these specially.

We know that, notwithstanding their great variety, the rocks

* Vol. xvi., p. 317 : 6th livraison. 1859.

which compose the terrestrial crust contain but a small number of minerals.* It seems even that certain minerals were unable to form themselves without others being developed at the same time. Thus, when there are felspars in a rock, we also most usually find the micas, augite, or hornblende. Similarly it is rare for orthoclase to be met with, without quartz. The associations of minerals are besides observed as well in normal and in abnormal rocks. In addition, as has been shown by Messrs. Breithaupt, Henwood, and B. Cotta, the minerals have generally succeeded in the same order.† It cannot, therefore, be doubted that minerals manifest a great tendency to form constant associations.

There is eminently one particular case in which the associations are very evident, and as intimate as possible; it is when two minerals are crystallized in such a manner that the one envelopes the other: we then say that there is envelopment.

Envelopment.

The envelopment of minerals is well fitted to throw light on the conditions in which they were formed, and has consequently attracted special attention. The older geologists occupied themselves with this subject, particularly Romé de l'Isle, De Bournon, Haüy, Gerhard, Gallois, Germar, Marx, Von Born, Werner, Karsten, Mohs, Chrichton, and Phillips. More recently, it has been noticed in diverse circumstances by Messrs. Breithaupt, Naumann, G. Bischof, Haussmann, Haidinger, Scheerer, G. Rose, Sillem, Zippe, Von Zepharovitch, Tamnau, Wieser, Wiebye, A. Knop, Websky, Marbach, Genth, Liebener, Null, Levy, Durocher, Sir David Brewster, H. C. Sorby, Silliman, Alger, Nicol, Jackson. But it is particularly to Messrs. R. Blum, G. Leonhard, Kenngott, A. Seyffert, and Söchting, that we owe the principal labours on envelopment.‡

When we regard the question in its widest generality, one mineral may envelope an almost indefinite number of other minerals; the old popular maxim, "tout est dans tout," seems to be verified for the mineral kingdom.

However, the number of minerals enveloping and enveloped is not so great as we might at first sight suppose; indeed, they may be considerably reduced if we limit them to those which are well crystallized, and the most important.

The following is a table which gives a résumé of these, and shows us the envelopment of the principal minerals. The classification adopted is that of Mr. Dana ("System of Mineralogy"). The enveloping mineral is given in the first column of the table, and the

* On this subject see my paper "On Rocks." "Geologist," vol. ii., p.p. 49 and 22.—H. C. S.

† Breithaupt, "Paragenesis der Mineralien." Henwood, "Phil. Mag.:" 1846, p. 360. B. Cotta, "Erzlagerstätten:" 2nd ed., p. 72.

‡ "Naturw. Verein in Halle," 1853, t. xi.: 6, Hollandische Societät der Wissenschaften zu Haarlem: 1851.

TABLE I.—ENVELOPMENT.

Enveloped Minerals.

Enveloping Mineral.	Simple Bodies &c.	Sulphides, Arsenides.	Fluorides, Chlorides.	Oxides.	Silicates.	Tungstates, Sulphates, Phosphates.	Carbonates.	Organic Substances.
Simple Bodies.								
Copper	Silver							
Iron					Olivine			
Bismuth	Gold							
Tetradymite	Gold							
Antimony	Arsenic	Antimonite, pyrargyrite						
Arsenic		Antimonsilber						
Sulphur		Galena					Calcite	Lignite
Diamond	Gold, diamond			Rutile				
Sulphides, Arsenides.								
Bismuthine	Gold							
Antimonite				Quartz		Baryte		
Realgar		Antimonite, cinnabar						
Argentite				Quartz				
Phillipsite		Redruthite, towanite						
Galena	Silver	Blende, pyrrhotine Pyrite, towanite	Fluor	Quartz	Garnet	Baryte	Calcite, Cerussite	
Blende		Galena, pyrite		Spinelle (Gahnite)				
Redruthite		Phillipsite, towanite						
Pyrrhotine		Galena, pyrite, towanite						
Pyrite	Gold	Galena, cinnabar	Fluor	Rutile	Zircon, mica	Gypsum		Combustibles
Cobaltine		Towanite, fahlerz		Quartz	Hornblende	Annabergite	Calcite	
Smaltine				Quartz				
Mispickel		Cobaltine		Quartz	Tourmaline			
Skutterudite	Graphite	Cobaltine		Quartz	Talc			
Towanite		Pyrite						
Pyrargyrite		Argent-rouge, feurblende						
Bournonite		Pyrite					Chalybite	
Fluorides, Chlorides.								
Rock-salt		Towanite	Rock-salt, fluor	Water		Anhydrite, glauberite, boracite		Carburetted hydrogen, vegetables, animals
Bromite	Silver							

Fluor	Silver	Argentite, galena, blende, breithauptite, pyrite, marcasite, mispickel, aikinite, towanite	Fluor	Hematite, water, bismuthochre, quartz	Hornblende, axinite, mica, orthoclase, euclase, tourmaline, chlorite, carpholite, argile	Baryte, herderite	Calcite, dolomite	
Cryolite		Galena, blende, towanite					Chalybite	
Oxides.								
Spinelle	Gold	Galena, blende		Corundum	Augite, garnet, mica.		Calcite	
Magnetite		Towanite		Quartz	Augite, hornblende, asbestus, garnet, epidote, talc, serpentine, chlorite, analcime		Calcite	
Franklinite					Willemite			
Spartatite				Franklinite				
Pechuran							Chalybite	
Corundum				Magnetite, corundum, diaspore	Mica			
Hematite	{ Paladium { Mercury			Magnetite, magno-ferrite, rutile, quartz	Garnet, felspar		Chalybite	
Ilmenite					Mica			
Cassiterite				Quartz	Emerald, mica			
Rutile				Hematite	Chlorite			
Anatase				Rutile				
Chrysoberyl				Quartz	Garnet, mica, tourmaline			Brewstoline, cryptoline
Diaspore				Corundum	Gadolinite, mica			
Limonite	Gold, silver		Kerargyrite	Hematite	Hypochlorite		Chalybite	
Valentinite		Antimonite						
Kermes		Antimonite						
Bleinierite		Jamesonite						
Quartz	Gold Silver Electrum Copper Arsenic Sulphur Graphite Diamond	Bismuthine, antimonite, argentite, galena, alabandine, blende, cinnabar, pyrrhotine, pyrite, marcasite, mispickel molybdenite, towanite, zinckenite, heteromorphite, pyrargyrite, cuivre-gris, stephanite	Sylvine Rock-salt Fluor	Magnetite, water with chlorides and sulphides, ilmenite, hematite, cassiterite, rutile, brookite, anatase, chrysoberyl, pyrolusite, göthite, limonite, bismuthochre, kermes, arsenite, wolframine, quartz	Augite, hornblende, (grammatite, actinote, amianthus, krokydolite), acmite, emerald, humite, garnet, zircon, idocrase, epidote, axinite, iolite, mica, nacrite, orthoclase, albite, topaz, ilvaite, andalusite, kyanite, sphene, tourmaline, talc, chlorite, ripidolite, chabasite, stilbite, carpholite, calamine	Scheelite, wolfram, lehmannite, baryte celestine, mirabilite, gypsum, melanterite, klaprothine, erythrine	Calcite Dolomite Magnesite Chalabite	Bitumen Naptha Anthracite Brewstoline Cryptoline

(*This Table will be continued next month.*)

mineral enveloped in the following ones. Although the minerals enveloping or enveloped are generally inorganic, they may also be organic, and these are also given in the table. A particular attention has, besides, been given to the examination of minerals in which any metamorphism has been noticed, and we shall see further on that this supposed metamorphism often finds a perfectly natural explanation in envelopment.

The table shows at once that the enveloping minerals, as well as the enveloped minerals, may appertain to every family of the mineral kingdom. It informs us in addition, as to the most habitual association of the divers minerals, and it enables us to embrace it at a glance. Some interesting peculiarities merit pointing out in the first place.

Envelopment of varieties of one same mineral.—Envelopment may easily be established, not only between different minerals, but also among varieties of the same mineral. Then the name of this mineral has been inscribed both in the columns of enveloping and enveloped minerals. The following are some examples.

Among the best crystallized bodies, as the diamond, in the midst of the most limpid sorts there are dull or even completely black parts, which form in certain cases species of fixed *astéries.*

Hyalin quartz often encloses independent crystals of quartz equally hyalin. In Iceland-spar M. Des Cloizeaux has observed crystals of carbonate of lime which are perfectly distinct from it. The hornblende of crystalline schists is often formed of common (aluminous) hornblende enveloping actinote.

The silver-white mica of granite frequently encloses another mica which is blackish or pinchbeck brown.

Tourmaline presents, particularly, very distinct varieties in one same crystal; thus, that at Chesterfield is green at the exterior, and a fine rose colour in the interior. On the other hand, the opposite may also happen, as is shown by a tourmaline of Mursinsk, in Siberia, belonging to the collecion of Mr. Damour. In certain tourmaline crystals we even observe several alternations.

The leucite of Vesuvius appears in small globules with concentric zones, in which a transparent zone is comprised between two opaque

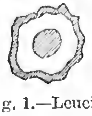


Fig. 1.—Leucite.

zones (Fig. 1). In the large leucite crystals of Roccamonfina, the transparent and opaque zones succeed each other in considerable numbers. Sometimes it is the same with felspar, and particularly with the orthoclase of the porphyritic granite of the Vosges.*

* "Recherches sur les Roches Globuleuses" (Mémoires de la Société Géologique, 2nd sèrie, tome iv., p. 301).

The idocrase of Arendal, according to Mr. G. Leonhard, presents a series of crystals which fit well with each other; their lustre diminishes as they recede from the centre, and it may even occur that their circumference may be formed of a returning zone of lustre.

The quartz of the Alps offers, in certain cases, a series of crystals which fit each other; and each successive increase is very well indicated by the parallel zones of ripidolite (fign 2).

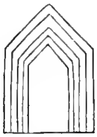


Fig. 2.—Parallel Zones of Ripidolite.

A very small quantity of foreign matter, or a slight alteration in the structure suffice besides to change the aspect of a mineral; but in several of the examples which have just been cited, the density, the chemical composition, and all the properties have been completely modified. In reality, the envelopment of the tourmaline, of the hornblende, of the mica, has taken place between very distinct minerals, which yet belong to the same mineral species.

The envelopment of varieties of one same mineral is easily seen in the diamond, fluor, rock-salt, corundum, quartz, augite, hornblende, garnet, idocrase, epidote, iolite, felspar, leucite, mica, andalusite, kyanite, sphene, tourmaline, topaz, serpentine, wolfram, baryte, gypsum, calcite, chalybite,. It is rendered perfectly sensible by the changes in lustre, colour, transparency, by a mixture of organic matters, of metallic oxides or sulphides, of argile, of chlorite, or of any other foreign substance; in a word, it is shown by the very smallest differences, whether in the physical properties or in the chemical properties. It may be attributed either to a slow crystallization effected in a liquid, or in a medium of variable composition, or to a severance occuring between the parts at the moment of crystallization.

Reciprocal envelopment.—The envelopment of two minerals is sometimes reciprocal. Thus quartz envelopes baryte; and on the other hand, the latter envelopes quartz. It is the same with kyanite and staurolite.

More frequently, when two minerals present a reciprocal envelopment, it is found in different localities; yet, in certain cases, they are not merely in the same locality, but united in the same rock. For example, in the crystalline schists of St. Gothard, at times the staurolite envelopes the kyanite, and at times, on the contrary, is enveloped by it. In the pegmatite of Mourne, in Ireland, the orthoclase impresses itself on the quartz, while in the cavities of this same peg-

matite the quartz supports the crystals of orthoclase, and, on the contrary, impresses itself on them.*

Mr. G. Rose has pointed out that in granite, the silver-white mica, which is very aluminous, generally envelopes the blackish or pinchbeck brown, which is ferro-magnesian. On the other hand, I have established a reciprocal envelopment of the former in the granite of Cornwall, which is employed in buildings in London; its micas form, in fact, agglomerations in which it is the ferro-magnesian mica which, on the contrary, envelopes the aluminous mica (fign. 3).

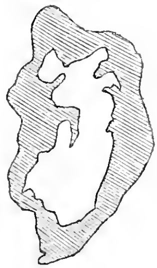


Fig. 3.—Ferro-magnesian Mica enveloping Aluminous Mica.

Finally, reciprocal envelopment is also observed in the same rock, and, what is more, at the same point. For, according to Mr. Scheerer, the orthoclase felspar of the syenite of Norway envelopes the mesotype (spreustein), which, in its turn, envelopes a kernel of this same felspar; so that a zone of mesotype is confined between two zones of felspar.

Mr. Blum has shown that the garnet of Pittigliano, in Italy, contains in its cavities crystals of idocrase and garnet, which penetrate and envelope each other mutually. According to Messrs. Seyffert and Söchting, it is the same with rutile and hematite in the valley of Tavetsch.

The following are the principal examples of reciprocal envelopment:—Pyrite and fluor, galena and fluor, fluor and quartz, rutile and hematite, magnetite and asbestus, magnetite and talc, magnetite and chlorite, franklinite and willemite, chrysoberyl and quartz, corundum and diaspore, quartz and emerald, quartz and garnet, quartz and topaz, quartz and baryte, quartz and scheelite, quartz and calcite, quartz and chalybite, augite and hornblende, emerald and topaz, garnet and idocrase, garnet and gypsum, garnet and calcite, epidote and scapolite, aluminous mica and ferro-magnesian mica, mica and andalusite, mica and kyanite, mica and tourmaline, felspar and tourmaline, felspar and mesotype, felspar and calcite, andalusite and kyanite, bastite and serpentine.

To resume, reciprocal envelopment is observed among all the

* Bulletin de la Société Geologique, 2nd sèrie, t. x., p. 568.

families of the mineral kingdom; it often occurs between the varieties of same species or between minerals which have some analogy in their chemical composition; it is very frequent among the silicates; it is equally so with quartz, and in general with the minerals which constitute the metalliferous deposits, or abnormal rocks.

General results.—As is seen by Table I., the enveloping and enveloped minerals are very numerous, and still, far from being exaggerated, their list might have been considerably augmented. It would have sufficed, in fact, to join to it the minerals which are formed in rocks; for the saccharoid limestone, for example, envelopes a large part of the known minerals, and these latter have crystallized at the same time as it.

Besides, when a mineral has been formed, it has generally been contaminated by foreign substances, amorphic or crystalline, organic or inorganic, which have been mixed with it and have modified its colour and other properties; thus, when even a crystal is transparent, it is extremely rare for it not to contain foreign substances. When these substances are not visible to the naked eye, they are easily recognized by the microscope, or chemical analysis. But the minerals which figure in the foregoing table are only the most common, and more especially those which, being crystalline, have been observed in another mineral equally crystallized.

The enveloping minerals which are the most important, and which enclose the greatest number of other minerals, are particularly fluor, quartz, the micas, the felspars, garnet, idocrase, scapolite, tourmaline, augite, hornblende, serpentine, chlorite, talc, baryte, gypsum, apatite, calcite, dolomite, chalybite. It is easy to see that they are very widely spread, and that they essentially constitute rocks. On the other hand, certain minerals, equally wide spread, such as blende, hematite, olivine, sphene, only rarely enclose other minerals.

The most common enveloped minerals are very nearly the same as the enveloping minerals. We should, however, add the more widely spread metallic minerals, particularly antimonite, galena, blende, pyrrhotine, pyrite, towanite, magnetite, hematite, rutile, wolfram.

The enveloping and the enveloped mineral pretty often present a certain analogy in their composition. Thus, the sulphides, arsenides, quartz, and the silicates, phosphates, carbonates, are found especially associated with minerals of the same family. However, there is no general rule in this respect, and the minerals offering the widest differences in their composition may readily be found associated. We thus understand how, according to the table given, quartz envelopes at least a hundred substances, and is itself enveloped by some forty; how calcite envelopes at least seventy substances, and is enveloped by more than a score. Besides, the cases of quartz and calcite clearly show that the enveloping or enveloped minerals may belong to almost all the families. The simple bodies, the sulphides, oxides, fluorides, the silicates, sulphates, phosphates, carbonates,

figure alternately among the enveloping and enveloped minerals. There are even organic substances which envelope certain minerals. These, on the other hand, are found in certain varieties of quartz, topaz, and chrysoberyl; I have shown, moreover, that they exist in small quantities in most minerals, sometimes even in those which are volcanic. Finally, organized bodies, vegetables or animals, are also observed in rock-salt and in amber.

To sum up, whether they are enveloping or enveloped, the minerals belong to all the families of the mineral kingdom. However, silica and the silicates, carbonates and sulphates are much more frequently enveloping and enveloped than the sulphides, arsenides, and metallic oxides. It is easy, indeed, to understand this; for while the latter minerals are exceptional, the former are on the contrary very frequent, and constitute the greater portion of the terrestrial crust.

As to the origin of enveloping and enveloped minerals, it is very variable. The more frequently it is aqueous, but it may also be igneous. It is even possible that it may be different for the two associated minerals.

The decomposition of a mineral generally gives rise to an envelopment. This decomposition is produced by oxygen, water, carbonic acid, or indeed by any other chemical agent. It is particularly frequent in the minerals susceptible of passing to a higher degree of oxidation.

It is the minerals of the abnormal and metalliferous rocks that visibly offer the greatest number of envelopments. This is to be attributed to their mode of formation, which is usually by successive deposits, so one mineral must cover the one that has preceded it.

This preamble on the envelopment of minerals was necessary for the understanding of pseudomorphism, which will now occupy our attention.

(To be continued.)

THE EVIDENCES OF THE GEOLOGICAL AGE AND HUMAN MANUFACTURE OF THE FOSSIL FLINT IMPLEMENTS.

By the Editor.*

In this notice we commence the first of a series of articles descriptive of the geological diagrams, of which last month we commenced the issue. The notoriety which the discovery of flint implements of human manufacture of Amiens and Abbeville by M. Boucher de Perthes has attained, and the amount of research and investigation now going on renders it necessary for us to lay before our readers the chief points of the proofs of the *human* workmanship of

* Being an illustrated explanatory article of Mr. Mackie's Geological Diagram, No. VI.

those articles. Figures 1 and 2 represent in outline on a scale of one sixth the two principal forms of the larger kinds of flint implements, such as are found in France, England, and elsewhere, wherever such remains have been

Fig. 1.—Large Flint Implement from St. Acheul. Collected by M. Boucher de Perthes.

Fig. 2.—Large Flint Implement, probably javelin head, found by Mr. Flower. Nat. Size: 8 inches by $3\frac{3}{4}$ inches.

found. Fig. 2 is the decisive implement as to the correctness of the position of the instruments in gravels of really geological age, found by Mr. J. W. Flower, of Croydon, at St. Acheul, near Amiens, in the presence of Mr. Prestwich and other geologists, in June of last year. This specimen was extracted from a seam of ochreous gravel (2*b* of section below) twenty feet below the surface. The section of the geological deposits at that place as given by Mr. Prestwich (in descending order) are

	Average thickness.
1. Brown brick-earth (many old tombs and some coins) with an irregular bed of flint-gravel. No organic remains. *Divisional plane between* 1 *and* 2 *uneven and very often indented*	10 to 15 feet.
2*a*. Whitish marl and sand, with small chalk-debris. Land and freshwater shells (*Lymnea*, *Succinea*, *Helix*, *Bithynia*, *Planorbis*, *Pupa*, *Pisidium*, and *Ancylus*, all of recent species) are common, and mammalian bones and teeth are occasionally found	2 to 8 feet.
2*b*. Coarse sub-angular flint-gravel, white with irregular ochreous and ferruginous seams, with tertiary flint pebbles and small sandstone-blocks. Remains of shells as above, in patches of sand. Teeth and bones of ele-	

	Average thickness.
phant and of species of horse, ox, and deer, generally near the base. This bed is further remarkable for containing the worked flints ("haches" of M. de Perthes, and "langues des chat" of the workmen)	6 to 12 feet.

resting on

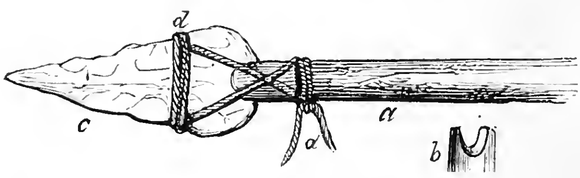
Uneven surface of Chalk strata.

In the stratum 2*b* the flint implements are found in considerable numbers. Mr. Prestwich tells us in his paper read before the Royal Society, that on his first visit he obtained several specimens from the workmen. The late Dr. Rigollet mentions the occurrence also here in the gravel of round pieces of hard chalk, pierced with holes, which he considers were used as beads. Such were also found by Mr. Prestwich on his visit, and recognized as small fossil sponges (*Coscinopora globularis*, D'Orb), very common in the Chalk. He expresses some doubt about their artificial dressing, although he admits "some specimens do certainly appear as though the hole had been enlarged and completed." We figure a specimen.

Supposed Fossil Bead.

These gravel-beds at St. Acheul cap a low chalk hill a mile south-east of the city of Amiens, and are about a hundred feet above the valley of the Somme, and are not commanded by any higher ground.

Fig. 2 is also from the gravel of Amiens, and is a very good example of the large pear-shaped implements. The specimen No. 2 is a type of another and flatter kind, and was probably used as a javelin, or spear-head, while the largest pear-shaped specimens like fig. 1 were probably used for digging roots, as the upper extremity is unworked, and left bulbous in shape, as if for fitting the palm of the hand when in use. It seems there are two sorts of pear-shaped flints,



Flint Implement (*c*) lashed to a stout pole (*a*) by cord (*d*), as a spear-head; *b*, notch at end of pole for end of instrument.

and that some were used like fig. 1 as javelin, or spear-heads. Sir Charles Lyell has in his collection one of these worked flints thus lashed on to a stout pole, in illustration of their probable use as javelin-heads, of which we give a representation below.

In the gravel deposit on which the town of Abbeville stands, a number of flint implements have been found, together with teeth of *Elephas primigenius* and, at places, fragments of fresh-water shells. The section, however, which Mr. Prestwich considers of great interest is that at Menchecourt, a suburb to

the north-west of the town. The deposit there is very distinct in its character, and occurs as a patch on the side of a chalk hill, which commands it to the northward, while it slopes down under the peat-beds of the valley of the Somme to the southward. The following is the section in descending order, as given by Mr. Prestwich.

	Average thickness.
1. A mass of brown sandy clay, with angular fragments of flints and chalk-rubble. No organic remains. Base very irregular and indented into bed No. 2	2 to 12 feet.
2. A light-coloured sandy clay ("sable gras" of the workmen) analogous to the loess, containing land-shells, *Pupa*, *Helix*, *Clausilia*, of recent species. Flint-axes and mammalian remains are said to occur occasionally in this bed	8 to 25 feet.
3. White sand ("sable aigre"), with one to two feet of sub-angular flint-gravel at base. This bed abounds in land- and fresh-water-shells of recent species of the genera *Helix*, *Succinea*, *Cyclas*, *Pisidium*, *Valvata*, *Bithynia*, and *Planorbis*, together with the marine *Buccinum undatum*, *Cardium edule*, *Tellina solidula*, and *Purpura lapillus*. The author has also found the *Cyrena consobrina* and *Litorina rudis*. With them are associated numerous mammalian remains, and it is said flint implements..	2 to 6 feet.
4. Light-coloured sandy marl, in places very hard, with *Helix*, *Zonites*, *Succinea*, and *Pupa*. Not traversed	3 feet.

M. Buteux enumerates from this pit the remains of *Elephas primigenius*, *Rhinoceros tichorhinus*, *Cervus Somonensis*, (?), *C. tarandus*, *C. priscus*, *Ursus spelæus*, *Hyæna spelæa*, *Bos primigenius*, *Equus adamaticus*, and *Felis*.

Of this section, however, Mr. Prestwich remarks that the essential work has yet to be done, namely, the determination of the manner in which these fossils are distributed, which occur in strata Nos. 2 and 3. "A few marine shells," that geologist tells us, "occur mixed indiscriminately with the freshwater species, chiefly amongst the flints at the base of No. 3. They are very friable, and somewhat scarce. It is on the top of this bed of flints that the greater number of bones are found, and also, it is said, the greater number of flint implements." Mr. Prestwich, however, only saw some long flint flakes (considered by M. de Perthes as flint knives) from the peat-beds and barrows. There are specimens, however, of the larger implements, or "haches," from Menchecourt, in M. de Perthes' collection; one from a recorded depth of five metres, and another from a recorded depth of seven metres. This would take them out of No. 1 stratum, but leaves it uncertain whether they came from No. 2 or No. 3. From this general appearance, Mr. Prestwich is disposed to place them in bed No. 2, but M. de Perthes believes them to be from No. 3—if so, Mr. Prestwich thinks they must have come from some subordinate clay-seams occasionally intercalated in the white sand.

With regard to the geological age of these beds, Mr. Prestwich considers them as belonging to the period usually designated as Post-pliocene, and notices their agreement with many beds of that age in England. The Menchecourt deposit thus resembles that of Fisherton, near Salisbury; the gravel of St. Acheul is like some on the Sussex coast; that of Moulin Quignon resembles the gravel so well exposed in the great railway ballast-excavation at East Croydon, and the gravel at Wandsworth-common, and many other places round London.

Besides the concurrent testimony of the workmen and of capable geologists, the flint implements bear evidence in themselves of their geological age. "It is a peculiarity of chalk flints to become deeply and permanently stained and changed in colour, or to remain unchanged, according to the nature of the deposit in which they are embedded, In clay beds the outside of flints become opaquely white or porcellanic; in sand their black fractured surfaces remain almost unchanged, whilst in beds of ochreous and ferruginous sands the flints are stained of light yellow, tawny, or deep brown colours, as is well exhibited in the ordinary gravels of the London area. This change is the work of very long time and of moisture before the opening of the beds. Now in looking over the large series of flint-implements in M. de Perthes' collection, it cannot fail to strike the most casual observer that those from Menchecourt are almost always white and bright, whilst those from Moulin Quignon have a dull yellow and brown surface; and it may be noticed that whenever (as is often the case) any of the matrix adheres to the flint, it is invariably of the same nature, texture, and colour as that of the respective beds themselves. In the same way at St. Acheul, where there are beds of white and others of ochreous gravel, the flint implements exhibit corresponding variations in colour and adhering matrix, added to which, as the white gravel contains chalk debris, there are portions of the gravel in which the flints are more or less coated with a film of deposited carbonate of lime; and so it is with the flint implements which occur in these portions of the gravel. Further, the surface of many specimens is covered with dentritic markings. Some few implements also show, like the fractured flints, traces of wear, their sharp edges being blunted. In fact, the flint-implements form just as much a continuous part of the gravel itself, exhibiting the action of the same late influences, and in the same force and degree, as the rough mass of flint fragments with which they are associated."

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London, March 28, 1860.

1. "Notes about Spitzbergen in 1859." By James Lamont, Esq., F.G.S.

M. Lamont first visited Edge's Land, which is composed of horizontal strata of limestone, shale, and sandstone, with some coal. One of the glaciers on this coast has a frontage of thirty miles. Black Point yielded some Carboniferous fossils. The Thousand Isles are composed of greenstone, sometimes columnar. Stour Fiord and Walter Thymen's Straits were next visited. The shores consist of the same kind of horizontal strata, with trap-rocks. Bell Sound and Ice Sound, on the west coast, were also examined; the former has high hills of grey fossiliferous limestone all round it; the fossils, as determined by Mr. Salter, prove to be all carboniferous. At various points on the coast and islands of southern Spitzbergen Mr. Lamont found bones of whales and walrus at elevations of ten to one hundred feet above the sea, and at distances of from a few yards to half a mile inland. The bones are sometimes embedded in banks of moss. Drift-wood (pine) also abounds; some of it lies thirty feet above high-water-mark.

In the supplement to this paper, Mr. Horner supplied a description of the rock-specimens brought from northern Spitzbergen by Parry and Foster in 1827. From the evidence thus afforded it appears that the islands and mainland about the entrance of Waigatz Straits consist of granitic and gneissic

rocks with quartz-rock and crystalline limestones—possibly the altered equivalents of the Carboniferous sandstones and limestones of southern Spitzbergen.

2. "On the so-called Wealden Beds at Linksfield." By C. Moore, Esq., F.G.S.

The author recognized a similarity of appearance between the shales and thin limestone-beds at Linksfield and those of the Bone-bed series (at the base of the Lias) at Pylle Hill, near Bristol, at Aust Passage and at Penarth, on the Severn, and at the Uphill cutting on the Great Western Railway. The author pointed out some close lithological resemblances, and stated that he recognized the "white lias," the "Cotham marble," the "bone-bed," and the gypseous clay-bands of the south in the quarry at Linksfield. *Cyprides*, *Estheriæ*, remains of *Hybodus*, *Lepidotus*, *Acrodus*, and *Plesiosaurus*, *Mytilus*, *Modiola*, *Unio*, and *Cyclas*, from the Linksfield beds, were among the palæontological evidences supporting his correlation of the beds in question.

April 18, 1860.

1. "On a Well-section at Bury Cross, near Gosport." By James Pilbrow, Esq. In a letter to the Assistant-Secretary.

This well, which was dug to a depth of one hundred and ten, and bored two hundred and twenty-one feet deeper, appears not to have penetrated the Bracklesham series of sands and clays, many of the characteristic fossils of which, obtained from the well, were exhibited by Mr. Pilbrow, together with specimens of the beds perforated. The yield of water in this well is very copious, certainly equal to five hundred thousand gallons at about seventy feet from the surface. When not pumped, the water rises to about nine feet from the surface.

2. "On the presence of the London Clay in Norfolk, as proved by a boring at Yarmouth." By J. Prestwich, Esq., F.G.S.

In 1840 Sir E. Lacon and Co. commenced a well, for the supply of water to their brewery, and had a shaft dug to the depth of twenty-two feet, and then a boring made to the depth of five hundred and ninety-seven feet, entering the Chalk, but stopped by massive flints. The work was unsuccessful; but the specimens of the strata were carefully preserved: Mr. Prestwich and Mr. Rose lately examined them, and the following is Mr. Prestwich's opinion of the strata that they represent:—blown sand and shingle, about fifty feet; recent estuarine deposits (with *Ostrea edulis*, *Cardium edule*, *Corbula Nucleus*, *Tellina Balthica*, *T. planata*, *Cyprina Islandica*, *Pecten opercularis*, *Mytilus* and *Balanus*), one hundred and twenty feet; London Clay, three hundred and ten feet; Woolwich and Reading series, forty-six feet; Chalk, fifty-seven feet.

This section is interesting as being illustrative of the estuary and its filling up; and of the extension of London Clay and Lower Tertiary deposits to a more northerly point than had previously been ascertained.

3. "On some Foraminifera from the Upper Triassic Clays of Chellaston, near Derby." By T. Rupert Jones, Esq., F.G.S., and W. K. Parker, Esq., M. Micr. Soc.

Bluish-grey specimens of the mottled clay from the pits at Chellaston, three miles south of Derby, whence the alabaster is obtained, yielded abundance of minute *Foraminifera*, a few *Entomostraca (Cythere)*, some Otolites, and spines and plates of small Echinoderms, together with fine siliceous sand and pyritous granules. Of the Foraminifera nearly one-half consist of a small variety of *Rotalia repanda*, namely, *R. elegans*, D'Orb. The next most numerous group are the *Nodosarinæ*, including varieties of *Nodosaria*, *Dentalina*, *Marginulina*, *Vaginulina*, *Planularia*, *Frondicularia*, *Flabellina*, and *Cristellaria*. The genus

next in numerical force is *Nubecularia, Polymorphina, Bulimina,* and *Lituola* are represented by a few individuals.

The authors stated that nearly all the varieties of the *Nodosarinæ* found at Chellaston are present in the Lias, in the clays of the Oolites, in the Gault, Chalk-marl, Chalk, some Tertiary deposits, and in some of the western Mediterranean and other seas; and the species of the other genera have also persisted to the present day. One of the Triassic forms was described as a new variety under the name of *N. Tibia.* After describing the distribution of Foraminifera in many of the Mesozoic strata, and pointing out that *Nodosariæ, Textulariæ, Rotaliæ,* and some other Foraminifera occur in the palæozoic rocks, Messrs. Jones and Parker observed that altogether we have here some remarkable instances of the persistency of life-types among the lower animals. "Though the specific relationship of the palæozoic Foraminifera require further elucidation, we feel certain that the six genera represented in the Upper Keuper Clay of Chellaston by at least thirty varieties stand really in the place of ancestral representatives of certain existing Foraminifera, that they put on their several subspecific features in accordance with the conditions of their place of growth, just as their posterity now do, and that, although we have in this instance met with only the minute forms of a seven hundred fathoms mud-bottom, yet elsewhere the contemporaneous fuller development of these specific types may be found by careful search in other and more shallow water deposits of the Triassic period."

May 2. 1860.

"On the Physical Relations of the Reptiliferous Sandstone near Elgin." By the Rev. W. S. Symonds, F.G.S.

Referring to Sir R. Murchison's sections of the Elgin district, in the Quart. Journ. Geol. Soc., No. 59, pp. 424 and 428, which show a conformable sequence of strata from the Old Red Sandstone of Foths to the yellow sandstone and cornstone of Lossiemouth and Burgh Head, the author stated that the siliceous marly rocks, or so-called "cornstones" of Glassgreen, Linksfield, Spynie, Invergie, and Lossiemouth are in reality very dissimilar to the cornstones of Foths and Cothall. He then pointed out the improbability of the so-called cornstones of Glassgreen continuing to dip north-westwardly under the sandstone of the Quarry-wood Ridge, especially as near Linksfield it is seen to dip away from that ridge. Evidence also of a break in the strata at the Bishop Mill quarries was brought forward to show that the sandstone beneath this "cornstone" (presumed to be the Reptiliferous sandstone) is probably brought by a fault against the lower or Holoptychian sandstone, which latter towards Spynie was shown to be surmounted by the Reptiliferous sandstone, and this last conformably by a marly siliceous rock or so-called "cornstone."

Beyond Spynie Loch, northward, the author supposed that another fault had again brought up the sandstone with *Stagonolepis* and *Hyperodapedon* at Lossiemouth. Beyond this a cornstone-like rock is again seen to cover the sandstone.

2. "Notice of the Discovery of two Bone-caves in Northern Sicily." By Baron Anca de Mangalaviti.*

May 16, 1860.

1. "Outline of the Geology of part of Venezuela and of Trinidad." By G. P. Wall, Esq. Communicated by Sir Roderick Murchison, V.P.G.S.

The district examined by Mr. Wall extends from the 8th degree north lati-

* A full account of these caves is given at page 312 of this volume.

tude to the sea, and eastward of the 69th meridian. It includes the Serranía (as the mountainous region is termed) and the Llanos or plains to the south.

The most ancient rocks in Venezuela consist of mica-schists and gneiss, and compose the author's "Caribbian Group."

These schistose rocks are highly distorted. In the western portion of the district they have a breadth of about thirty miles, and rise to the height of eight thousand feet.

Gneiss also is present, and is markedly interstratified with the mica-schists. The transition is occasionally gradual; but more usually it is sudden and abrupt. The gneiss sometimes assumes the irregular structure of granite, but is still distinctly bedded. It is occasionally auriferous. Very small proportions of copper-ores and argentiferous galena exist in some localities.

The Serranía also comprises another great group of strata, flanking the "Carribbian" rocks on the south, and in the eastern district rising to a height of more than seven thousand feet, with a breadth of from thirty to forty miles. These consist of sandstones, fossiliferous limestones, and shales, and form the group provisionally termed "Older Parian."

These Older Parian strata must be nearly eight thousand feet thick. They have been intensely disturbed. Though the fossils can rarely be separated from the matrix, yet some were fortunately obtained from near Cumaná—namely, *Trigoniæ* and small *Gasteropoda*—probably of Lower Cretaceous age. These Lower Parian rocks extend westward into New Granada, and are probably related to the Neocomian rocks of Bogotá. Near their junction with the "Caribbian Group" they are often interstratified and alternate with rocks of igneous origin.

The Llanos are entirely formed of conglomerates and sandstones referable to the "Newer Parian Group." In Trinidad a lower and calcareous portion exists. Altogether this group probably has a thickness of nearly four thousand feet. Fossils are abundant in the calcareous division, and seem to represent the Lower Pliocene or Upper Miocene series of Europe.

The upper portion of the Newer Parian series, which is often shaly, contains beds of lignite, frequently admitting of exploitation. The lignite occurs at several localities on the mainland, and also in Southern Trinidad. The lignitiferous beds have locally undergone combustion to a great extent, from natural causes, such as the decomposition of pyrites. The result is that the strata have been indurated and baked for a vertical extent sometimes of seventy or eighty feet, the clays assuming various conditions, and presenting the "porcellanites" and "thermantides" of continental authors.

The asphalt of Trinidad and the mainland is almost invariably disseminated in the upper part of the Newer Parian group. When *in situ*, it is confined to particular strata, which were originally shales containing a certain proportion of vegetable *débris*. The organic matter has undergone a special mineralization, producing a bituminous, in place of the ordinary anthraciferous substances. This operation is not attributable to heat, nor of the nature of distillation; but is due to chemical reaction at the ordinary temperature and under the normal conditions of the climate. After the solution and removal of the bitumen from wood passing into asphalt, the remaining organic structure presents peculiar appearances under the microscope.

The occurrence of asphalt in New Granada and the Valley of the Magdalena in all probability indicates the presence of the Newer Parian strata in those districts.

2. "On the co-existence of Man with certain Extinct Quadrupeds, proved by Fossil Bones from various Pleistocene Deposits, bearing Incisions made by sharp instruments." By M. E. Lartet, For. M.G.S. In a letter to the President.

The author having for some time past made observations upon fossil bones

exhibiting evident impressions of human agency, was requested by the President, who had examined the specimens indicated, to communicate the results of his researches to this Society.

The specimens referred to are:—1st, fragments of bones of *Aurochs* exhibiting very deep incisions, made apparently by an instrument having a waved edge; 2ndly, a portion of a skull of *Megaceros hibernicus*, bearing significant marks of the mutilation and flaying of a recently slain animal. These were obtained from the lowest layer in the cutting of the Canal de l'Ourcq, near Paris, and have been figured by Cuvier in his "Ossemens Fossilis." Molars of *Elephas primigenius* found in the same deposit are figured by Cuvier, who states that they had not been rolled, but had been deposited in an original and not a *remanié* deposit. 3rdly, among bones, with incisions, from the sands of Abbeville, are a large antler of an extinct stag (*Cervus Somonensis*) and several horns of the common Red-Deer. 4thly, bones of *Rhinoceros tichorhinus* from Menchecourt, near Abbeville, where flints worked by human hands have been found. 5thly, portions of horns of *Megaceros* from the British Isles. In reference to the remains of the Gigantic Deer, M. Lartet alludes to the Rev. J. G. Cumming's statement that stone implements have been found in the Isle of Man imbedded with remains of the *Megaceros*, and that hatchet-marks have been seen on an oak-tree in a submerged forest of possibly still older date. 6thly, fragments of bone collected by M. Delesse from a deposit near Paris, and exhibiting evidence of having been sawn, not with a smooth metallic saw, but with such an instrument as the flint knives or splinters, with a sharp chisel-edge, found at Abbeville would supply.

If, says the author, the presence of worked flints in the gravel and sands of the valley of the Somme have established with certainty the existence of man at the time when those very ancient deposits were formed, the traces of an intentional operation on the bones of *Rhinoceros, Aurochs, Megaceros, Cervus Somonensis*, &c., supply equally the inductive demonstration of the contemporaneity of those species with the human race. M. Lartet points out that the Aurochs, though still existing, was contemporaneous with the *Elephas primigenius*, and that its remains occur in pre-glacial deposits; and indeed that a great proportion of our living mammifers have been contemporaneous with *E. primigenius* and *R. tichorhinus*, the first appearance of which in Western Europe must have been preceded by that of several of our still existing quadrupeds.

The author accepts M. d'Archiac's determination of the period of the separation of England from the Continent as having been anterior to the formation of the ancient alluvium or "loess," but subsequent to the great rolled gravel-deposits in which the flint hatchets of a primitive people are found. If M. E. de Beaumont's hypothesis of these gravels being due to the last dislocation of the Alps be accepted, the worked flints carried along with the erratic pebbles afford a proof of the existence of man at an epoch when Central Europe had not yet fully received its present geographical features.

The author also remarks that though there is good evidence of the changes of level having occurred since man began to occupy Europe and the British Isles, yet they have not amounted to catastrophes so general as to affect the regular succession of organized beings.

Lastly, M. Lartet announced that a flint hatchet and some flint knives had lately been discovered, in company with remains of Elephant, Aurochs, Horse, and a feline animal, in the sands of the Parisian suburb of Grenelle, by M. Gosse, of Geneva.

May 30, 1860.

1. "On certain Rocks of Miocene and Eocene age in Tuscany, including Serpentine, accompanied by Copper-ore, Lignite, and Alabaster." By W. P. Jervis, Esq., F.G.S.

Three distinct eruptions of serpentinous igneous rocks have been recognized by the Italian geologists; two are considered to have occurred in Tertiary times, and one previously in the Mesozoic period: dykes of diorite (also of Tertiary age) are more rare in the same geographical area. From the abundant occurrence of these eruptive rocks, and the extensive development of Miocene strata, unknown in England, arise many pecularities of Tuscan geology and mineralogy. 1st. The diallagic serpentine has pierced the Upper Cretaceous beds, but does not enclose any fragments of Tertiary rocks. It is non-metalliferous, and is employed in architecture. 2ndly. The euphotide or "granitone," is unfit for building purposes. The contact of this with the diallagic serpentine has metamorphosed the latter into the curiously marked "Ranocchiaja," 3rdly. Diorite, penetrating the euphotide, and, like it, belonging to the Eocene age. This and the serpentine acting on the "Macigno' has produced the "Gabbro rosso." 4thly. "Gabbro verde," or serpentine, without diallage, of Miocene age. This is much softer than the diallagic serpentine. It forms dykes; but more generally it is the axial nucleus of hills and mountains, the strata of which are much disturbed. In most cases the serpentine rocks, piercing the sedimentary strata, have upheaved them from all sides. to this remarkable species of axis the author proposes the term *periclinal*, indicating that the strata fall off in every direction. The limestones are often altered by the serpentine into dolomite (Miemmite), and are otherwise variously affected Near Matarana a mouse coloured limestone is changed (by the alteration of the carbonate of iron to a peroxide) into a brick-red marble, often brecciated and veined with serpentine and calc-spar (Ofiocalce")

June 13, 1860.

1. "On the Ossiferous Caves of the Peninsular of Gower, in Glamorganshire, South Wales." By H. Falconer, M.D., F.R.S., F.G.S. With an Appendix by J. Prestwich, Esq., F.R.S., Treas. G.S., "On a Raised Beach in Mewslade Bay, and the occurrence of the Boulder-clay on Cefn-y-bryn, in Gower.

This communication was a summary of researches made during the last three years by the author and Lieut.-Col. Wood, F.G.S. The known bone-caves of Gower, (of which Paviland, Spritsail Tor, and Bacon Hole have already supplied Dr. Buckland and others to some extent with materials for the history of the Cave-period) are in the Carboniferous Limestone; and, with the exception of that of Spritsail Tor, which is on the west coast of the peninsula, they all occur between the Mumbles and the Worm's Head. The most important are "Bacon Hole," "Minchin Hole," "Bosco's Den," "Bowen's Parlour," "Crow Hole," "Raven's Cliff Cavern," and lastly the well-known "Paviland Caves." Bone-caves at the Mumbles, in Caswell Bay and in Oxwich Bay formerly existed; but the sea has destroyed them. One cavern named "Ram Tor" between Caswell Bay and the Mumbles, presumed to be ossiferous, remains unexplored.

Before describing the bone-caves, the author briefly noticed that which Mr. Prestwich had lately traced, a raised beach and talus of breccia, for a mile along Mewslade Bay, westward of Paviland; and he pointed out their important relationship to the marine sands and overlying limestone-breccia found in several of the Gower Caves. Some patches of Boulder-clay had also been found by Mr. Prestwich, on the highlands of Gower, and in Rhos Sili Bay.

"Bacon Hole" was first treated of. On the limestone floor of the cave are,—(1) a few inches of marine sand, abounding with *Litorina rudis*, *L. litoralis*, and

Clausilia nigricans, with bones of an *Arvicola* and birds; (2) a thin layer of stalagmite; (3) two feet or less of blackish sand, containing a mass of bones of *Elephas antiquus*, with remains of *Meles taxus* and *Putorius (vulgarus?)*; (4) one to two feet of ochreous cave-earth, limestone-breccia, and sandy layers, with remains of *Elephas antiquus*, *Rhinoceros hemitœchus*, *Hyæna*, *Canis lupus*, *Ursus spelæus*, *Bos* and *Cervus*; (5) irregular stalagmite, partly enveloping a hugh tusk of an Elephant embedded below it; (6) limestone-breccia and stalagmite, from one to two feet thick, with bones of *Ursus* and *Bos*; (7) irregular beds of stalagmite, one foot or more, with *Ursus*; (8) dark-coloured superficial earth, kept soppy by abundant drip, with bones of *Bos*, *Cervus*, *Canis vulpes*, horns of Reindeer and Roebuck, together with shells of *Patella*, *Mytilus*, *Purpura*, *Litorina*, (probably brought into the cavern as food by birds), and also pieces of ancient British pottery. The marine sand at the bottom of "Bacon Hole" was analogous to that on the rocky floor of the San Ciro Cave, near Palermo; but containing fewer species of Mollusca. The uppermost layer of stalagmite is about thirty feet above high water. The Elephant remains belong to at least three individuals, one of which was adult, and one young with milk-dentition.

"Minchin Hole," the grandest and most spacious of all the Gower Caves, is 170 feet long, 70 feet where widest, and 35 feet high at the entrance; the section gave—(1) Loose limestone-breccia, three feet; (2) Yellow cave-earth, nine inches; (3) Sand, one foot; (4) Blackish sandy loam containing abundant remains of *Rhinoceros*, *Elephas*, and *Bos*, two and a half feet; (5) Greyish-yellow marine sand, varying in thickness from one to four feet, and resting on the rocky floor. Some of the lower jaws of *Rhinoceros* from this deposit exhibit *Litorinæ* and comminuted shells imbedded in the encrusting matrix: and the black sand yielded *Helix hispida*, similarily attatched. In the interior, the cave-earth was thicker, and the black sandy loam more unctuous. The mammalian remains were closely analogous with those from Bacon Hole; but the Elephant remains (*E. antiquus*) were fewer, and those of *Rhinoceros hemitœchus* were more numerous, and better preserved. No remains of *Eleph. primigenius* or of *Rhinoc. tichorhinus* were met with in Bacon Hole or Minchin Hole.

"Bosco's Den," a cavernous fissure, between "Bacon Hole" and "Minchin Hole," is about seventy feet high. Col. Wood, having succeeded in reaching a hole called by the quarrymen "Bacon's Eye," found it to be an angular opening, two and a half feet in diameter, at the top of one the the great vertical fissures in the limestone, and leading into a fine cavern. Beneath it the fissure was filled up with a mass of angular fragments of limestone, with bones, teeth, and land shells, impacted in ochreous loam, about twenty feet in height, resting on a solid platform of breccia, beneath which, the fissure had to a great extent been washed out by the sea. On enlarging the aperture, by undermining the projecting mass of loam and breccia, a cavity was found extending seventy-six feet backwards, with a width of from seven to sixteen feet, and a general height of about fifteen feet. A line of fissures runs along the angle of the roof, and towards the outer part of the cavern the crack widens into an irregular flue, which had evidently communicated with the surface; here the cavern rises to a height of forty feet. The eastern wall only of the cavern was found to be coated with stalagmite. The floor was tolerably smooth and shelved down gradually, from the mouth to the extremity, the deposits being thicker outwards. The floor having been excavated down to the hard breccia, there were observed.—(1) at the top, a bed of sandy peat or turf, formed chiefly of bits of sticks and comminuted vegetable matter, about one foot thick, except under the flue, where it formed a low conical heap. In or on this peaty covering were bones of Ox and Wolf, and bones and broken shed antlers of Deer, of species or varieties allied to the Reindeer *(Cervus Guettardi* and *Cerv. priscus)*. (2)

Stalagmite, regular, but usually less than a foot thick. At one spot it rose into a boss two feet three inches high, which was found in a shattered condition, the fragments being loose, but still in place; thus indicating the operation of some shock since the formation of the stalagmite, and even since the peat began to be formed, as well as the absence of the drip in the cave since the shock took place; (3) sandy loam, one foot four inches, with fragments of rock and without bones; (4) sand, four feet six inches; (5) a bed of loose stony breccia, four feet, without bones; (6) ochreous loam, or the usual cave earth, six to seven feet thick, resting on the solid cemented breccia, which forms a floor or diaphragm between the upper and lower chambers of the fissure. *Ursus spelæus*, *Canis lupus*, *C. vulpes*, *Bos*, *Cervus*, and *Arvicola* occur in the loam, the latter in abundance. The most remarkable circumstance about these remains was the great excess or Deers' antlers above the others. Upwards of one thousand antlers, mostly shed and of young animals belonging *chiefly* to *Cervus Guettardi*, were collected. The lower chamber has been washed out by the sea to a depth inwards of thirty-one feet; and at its extremity a compact mass of marine sand and gravel, about nine feet thick. The solid breccia forming the roof of the lower, and the base of the upper cave, increases in thickness from six feet at the outside to a greater depth inwards. Its materials correspond with the bed of angular *débris* observed by Mr. Prestwich on the raised beach of Mewslade Bay.

"Bowen's Parlour," or "Devil's Hole," is also a cavernous fissure in the limestone cliff, between Bosco's Den and Crow Hole. It has been washed out by the sea; the former about twenty feet high at the mouth, the latter fourteen. Thin tabular aggregations of sand adhere to the lower surface of the partition, showing that it was deposited on a bed of sand. The same phenomena are repeated in "Crow Hole" with modifications; the cave deposits being still *in situ*: here remains of *Ursus*, *Meles*, *Rhinoceros*, and some other forms have been found.

"Raven's Cliff," presents a cavernous fissure broad and high externally, contracted within. Here a thin crust of stalagmite formed a floor upon sand nine feet thick, which filled the fissure close up to the roof, leaving only an empty angular chamber about a foot high above the stalagmite. Upon the latter, remains of *Mustela foina*, *Canis vulpes*, and some Fish-bones and Bird-bones were found. In the sand large coprolites of Carnivores, some fine remains of *Felis spelæa*, bones of *Rhinoceros*, and the vertebra of a Fish were discovered. Below the sand, as usual in the Gower Caves, there was a sandy breccia cemented by stalagmite, about a foot thick. Upon it was a large block of limestone, smoothed and polished, probably by the rubbing against it of cave-animals, and patches of polished surface were seen on the walls of the cave. Remains of *Elephas*, *Rhinoceros*, *Bos*, and *Cervus*, were met with above the breccia. Below the breccia was a bed of dark-grey gritty sand, indurated by calcareous infiltration, and attaining a maximum thickness of about eight feet. In this sand, and close upon the rock-floor, teeth of *Hippotamus major*, young and old, and remains of *Ursus*, *Cervus*, and *Arvicola*, were met with. There was evidence, on the cliff beyond the aperture, of the cave and its contents having formerly been continued further seawards.

The author pointed out that in all these caves the bottom appears to have been first filled with sea sand or shingle, with which were occasionally intermixed the bones of pachyderms, ruminants, &c., then living on the emerged land of Gower; that, when this deposit was elevated above high water mark, stalagmite and angular *débris* of limestone rock formed a floor, on which subsequently cave-earth or other common alluvial materials, with bones and antlers, often in profusion, were accumulated through the fissure above, during a long lapse of time after the rise had been accomplished. At last, by a converse action, of comparatively modern date, the level of the caves was depressed.

The raised beach at Mewslade Bay, which appears, according to the evidence of Mr. Prestwich, to be of later date than the Boulder-clay, has without doubt partaken of changes of level similar to what the caves and their contents have undergone; although the marine deposits in the caves not being at a uniform level, either in relation to each other or to the raised beach, it is probable that there have been locally unequal depressions of level in comparatively modern times. The author thinks that the sea has effected but a comparatively slight inroad on the cave-deposits and raised beach; and hence he infers that they belong to a comparatively modern epoch,—seeing also that they are probably of later date than the Boulder-clay period, and rest on marine sands containing existing species of shells.

Paviland Cave was next referred to; but the author restricted his remarks to the remains of *Elephas primigenius* and human bones that were found in it, and argues that the latter, (*i. e.* the skeleton of the "Red Lady") are of more recent date than the former.

In the cave at Spritsail Tor, under a stalagmitic bone-breccia, the irregular fissure of the rocky floor was impacted with ochreous cave-earth full of bones and teeth of *Elephas antiquus, E. primigenius, Rhinoceros, tichorhinus, Equus, Sus, Bos, Cervus, Lepus, Arvicola, Mus, Ursus spelæus, U. priscus* (?), *Felis spelæa, Hyena spelæa, Canis lupus, C. vulpes, Meles taxus,* and *Mustela.* Coprolites of *Hyæna*, gnawed bones of *Bos, Equus,* and *Cervus*, and a great abundance of the detached molars of horse, gave the cave the undoubted character of having been a Hyæna's den. In the superficial sand on the stalagmite, the antlers of a Reindeer and some human bones were found.

After a comparative review of the fauna of the Gower bone-caves in relation with that of other cave-districts of England, and of Europe in general, the author arrived at the following conclusions.

1. That the Gower Caves have probably been filled up wi h their mammalian remains since the deposition of the Boulder-clay.

2. That there are no mammalian remains found elsewhere in England and Wales referable to a fauna of a more ancient geological date.

3. The *Elephas (Loxodon) meridionalis* and *Rhinoceros Etruscus,* which occur in, and are characteristic of, the "Submarine-forest Bed" that immediately underlies the Boulder-clay on the Norfolk coast, have nowhere been met with in the British caverns.

4. That *Elephas antiquus,* with *Rhinoceros hemitœchus,* and *E. primigenius* with *Rh. tichorhinus,* though respectively characterizing the earlier and later portions of one period, were probably contemporary animals; and that they certainly were companions of the Cave-Bears, Cave-Lions, Cave-Hyænas, &c., and of some at least of the existing mammalia.

[The Geological Society's Meetings are resumed on the 7th inst.]

Geologists' Association.—Rev. Walter Mitchell will read a paper "On the Application of Crystallography to Mineralogy and Geology."

NOTES AND QUERIES.

Travertine Deposits along the Foot of Kinder Scout, Derbyshire.—It will perhaps be interesting to Manchester geologists to know that a deposit of travertine is now forming along the base of the above hill. The nearest deposits of this kind are at Matlock Bath, in the mountain limestone, a

distance of forty or fifty miles from Manchester. The above is formed by a little stream which flows out of the hill-side, and trickles slowly down to join a brook at the bottom. The bed is already about ten feet in thickness at its greatest, and about twenty or thirty feet in length; in composition it is rather harder and more compact than that found at Matlock, and like it contains incrustations and impressions of various leaves, lichens, and mosses, along with shells of the common *Helix*, &c.

Kinder Scout is a hill about one thousand nine hundred feet in height, and is one of the highest points in the Peak of Derbyshire; its distance from Manchester is about eighteen or twenty miles. The upper part is composed of the coarse millstone grit, containing rounded pebbles of quartz, and this passes into hard flaggy beds towards the bottom, where the travertine bed overlaps it, so to speak. The travertine is to me the more remarkable from its being found on the millstone grit, its nearest distance to the mountain limestone being five or six miles. The deposit is only known to a few individuals, and has not been brought under the notice of geologists before.

The locality may be found by following the course of the Kinder Water from Hayfield; this stream skirts the southern base of the hill, and is joined by the little brook into which the petrifying spring flows, almost at its head. Masses of travertine may be found in the bed of the stream towards the head, which will serve as a good guide to the explorer. It is said that great quantities of the travertine have been taken away.

The accompanying sketch is a view of the spot where the deposit lies; the flaggy beds of the sandstone are seen on the right, and the masses of travertine on the left hand. It is well worth a visit, and will repay the trouble of making one.—Yours, JOHN TAYLOR, Levenshulme.

AMERICAN FOSSILS.—SIR,—Could any of your readers put me in the way of procuring a specimen of *Maclurea*, and a few other American fossil shells, by exchange or otherwise.—SIGMA.

ARRANGEMENT OF MINERALS.—SIR,—Your obliging answer in the August number of the "GEOLOGIST" to my queries on the subject of the best way to

make a catalogue of fossils, induces me to trouble you with a few lines on the subject of a catalogue which I have nearly completed of my small collection of minerals.

I have arranged them according to the orders into which Professor Mohs and Haidinger divide minerals, as given in Allan's "Mineralogy."

Order.		Order.	
I.	Acid.	XI.	Gem.
II.	Salt.	XII.	Ore.
III.	Haloide.	XIII.	Metal.
IV.	Baryte.	XIV.	Pyrites.
V.	Kerate.	XV.	Glance.
VI.	Zerene.	XVI.	Blende.
VII.	Malachite.	XVII.	Sulphur.
VIII.	Mica,	XVIII.	Resin.
IX.	Steatite.	XIX.	Coal.
X.	Spar.		

I have also divided them into the chemical classes of

1st, Earthy and alkalino-earthy minerals,
2nd, Acidiferous minerals,
3rd, Metallic minerals,
4th, Combustible minerals,

by adding a column for this purpose to the catalogue.

I enclose a specimen sheet, and shall be glad if it meets with your approval. A few words on the subject of the principle upon which the above-mentioned "orders" were institued would greatly oblige me.

I may mention that I intend to mark each specimen with the number of the order to which it belongs, and that the drawers containing the minerals in each order are also numbered. As the subject may not be wholly uninteresting to some others of your readers, perhaps at your leisure you will kindly favour us with a few more suggestions in a future number of your magazine.—I remain, Sir, yours faithfully, A. B. M. W., Edinburgh.

Order XI.	Name of Specimen.	No.	Class.	Locality.
Gem.	Rock Crystal	1	Earthy minerals	Snowdon
	Cairngorum	2	ditto	Arran
	Black Quartz	3	ditto	
Species Quartz	Quartz Crystals	4	ditto	Cheddar
	Chalcedony	5	ditto	Lead-hills
	Flexible Sandstone	6	ditto	Thibet
	Heliotrope, or Blood-stone	7		Brun
Species Opal	Yellow Opal	8	ditto	Mexico

Order XII.	Name of Specimen.	No.	Class.	Locality.
Ore.	Specular Iron	1	Metallic minerals	Elba
	Wood Tin	2	ditto	Mexico
	Brown Hematite	3	ditto	Dover Cliffs

We recommend to our correspondent a copy of W. Phillips' "Mineralogy" (any edition before the one by Brooke and Miller, especially the 4th), and to arrange her collection in the order that Phillips' adopted and uses in his book. It is the most practicable for general purposes.

Elliott's Clinometers.—Sir,—Some time ago you promised to give an account of instruments in use by geologists. Will it be convenient, in the absence of this, to afford me some explanation of the two scales of the clinometer made for geologists by Elliott Brothers, Strand. The principal graduation on the brass arc is intelligible, being the quadrant divided into ninety degrees; but the arc contains an inner line 1 | 1, 1 | ½, 2, 3, &c. Query.

What is their signification? Again, on the compass side of the clinometer is a table divided into vertical columns, the first marked degrees, the second containing parts of the inch, corresponding to the degrees. How do they correspond with each other?—SIGMA.

The mark 1 | 1 signifies that the angle is such that the base is equal to the perpendicular; 1 in 2 that the base is double the perpendicular, and so on. The second column does not signify parts of an inch, but for a slope of one degree the rise is one in fifty-seven (one foot in fifty-seven feet, or one inch in fifty-seven inches, etc., etc.). For two degrees the slope or gradient would be one in twenty-eight and a-half, and so on.

HOCHSTETTER ON CHINESE FOSSILS.—Groups of crystals and organic remains are highly valued in China as ornaments of opulent apartments, and fetch most exorbitant prices. A group of common quartz crystals, of very common appearance, was offered to Dr. Hochstetter at the price of twenty Mexican dollars (about £4 4s.). Plates of dark brown limestone embedding splendid specimens of *Orthoceratites*, are, when polished and framed, highly esteemed as ornamental furniture for state apartments. They are said to be frequent at Yunnan. Their Chinese name of "pagoda-stone," adopted by Mr. Muirhead in his "Manual of Geology," published in the Chinese language, is derived from the general opinion that these *Orthoceratites*—showing indeed in their alveoles and in the septæ going through them a certain similitude with the structure of these buildings—are formed underground in places on whose surface the towers of a pagoda project their shadows.

Fossil bones and teeth of mammalia, as also tiger bones are much in request among the Chinese, on account of their supposed medical virtues, and are consequently sold by apothecaries at most reasonable prices. Two other sorts of organic remains occupy also a conspicuous place in the *materia medica* of the Chinese, and are sold in a pulverized state at about 1s. 3d. the ounce. One of them is the "stone-bird" (Sa-ji), a brachiopod from the Devonian Limestone of Tche-Saifn-tsi; the other is a crab, extremely well preserved in a (probably cretaceous) clay-marl, from Hainan Kukwang and Tché-kwang-tsi.

The material generally used for ornamental objects is the well-known Chinese steatite in its natural state, or artificially tinged with the most diversified colours. At Hing-po (one hundred and eighty sea miles south of Shanghai) and Tse-kong-sa, where these objects are principally fabricated, they are extremely cheap, but in very low esteem compared with objects of crystalline limestone or marble. Objects made of "tade" or "yo" (a denomination indiscriminately used for any mineral substance of a hardness equal to that of quartz, or at least superior to that of marble) fetch enormous prices. Trifles are sold for 8s. 3d. to 21s.; larger figures, dishes, vases, &c., are not to be had for less than £2 2s., £4 4s., and even if particularly conspicuous, £105. Further inquiries are necessary to establish a mineralogical determination between several green substances comprised under the general denomination of "yo," and to distinguish how far their colour is natural or artificial.

NOTES ON THE RED AND WHITE CHALK OF YORKSHIRE.—Having lately taken some trouble in getting specimens of the Red and the White Chalk of Yorkshire, and in examining them chemically and microscopically, I was interested in obtaining, with the aid of Mr. Deane, of Clapham, and of Mr. Norman, some *Foraminifera* from both of these hard varieties of chalk.

Very little impression can be made on this indurated chalk by washing it with water and a brush, the usual plan adopted for obtaining Microzoa from chalk; but Mr. Deane succeeded in breaking up the Red Chalk in the following method. He says, "Take any efflorescent salt (I prefer subcarbonate of soda, for the chance of its acting a little upon the silica); make a strong solution; boil the hard chalk therein till it is fully saturated; remove it from

the solution, and expose it either to the air or to the heat of an oven until the water of crystallization has escaped; then, this prepared chalk, when put into boiling water will probably break up without greater force being employed than a common painter's sash-tool will exert upon it. The fine particles should then be washed away; and the remainder will probably be found to consist of *Foraminifera*, and should be mounted in Canada-balsam, to be seen properly."

Some of the White Chalk of Yorkshire, however, requires to be sliced and polished before it can be examined microscopically. It is very intractable, as Mr. Norman, the well known microscopical mechanist, found, though he succeeded in overcoming the difficulty and in preparing some very good slides.

The Red Chalk from Flamborough, having been manipulated by Mr. Deane, was examined by Messrs. W. K. Parker and T. R. Jones, and was found to contain the following *Foraminifera*:—*Globigerina bulloides;* small, very common. *Textularia pygmæa;* small, common. *Rotalia ammonoides;* small, rather common. *Dentalina communis;* small, rather common. *Cristellaria rotulata;* of middling size, rare.

These gentlemen also inform me that the thin slices of the hard White Chalk from Flamborough, when magnified fifty diameters, are seen to be exceedingly full of minute chambers, or cells, of *Globigerina* and *Dentalina*; the former predominating. There are also a few *Textulariæ* observable. The chambers are generally separate; but here and there characteristic groups of them remain attached to each other. The general appearance is that of very finely washed common chalk.

These *Foraminifera* indicate a deep-sea-condition to have been that of the Chalk-deposit, and such as that of the mid-Atlantic or the Indian Ocean, where *Globigerina* still abounds.

Treated with acid, one of the specimens of the White Chalk exhibited evident remains of organic matter, such as what may well be considered as disintegrated dry sarcode of *Foraminifera*. It is chiefly globular; but some of it is filamentous.

Chemically examined, the Red Chalk gives 70 per cent. of carbonate of lime; the residue being quartz-grains and silicate of iron. Digested in very strong acid, about 4 per cent. of peroxide of iron is obtained. The White Chalk leaves scarcely any residue when treated with muriatic acid.—Major-Gen. Emmett, R.E., F.G.S.

Clay-Slate and Granite.—A correspondent in Halifax, Nova Scotia, mentions the following interesting facts:—"This province has many points of geological interest, which have been all ably dealt with by Dr. Dawson. In the small way, it is curious to observe the highly metamorphic condition of 'clay-slate' when more or less acted on by granite. I have a beautiful specimen of granite containing two still well-laminated fragments of slate. Another, in which the fragment seems turned into a granitoid stone; and every stage of the process is to be seen in all the chiselled blocks of 'ashlar' (granite) in the various buildings hereabouts, a disfigurement to the white granite, it is true, but very interesting to geological scrutiny. Also, this clay-slate has more than a tendency, at times, to turn into mica-slate. Once I caught it in the fact of looking very like rudimentary hornblende-slate.

There is a large boulder of the metamorphic slate on the hill above here, with equal tendencies to weather in coats, as we so frequently see in granitic cheesewrings, basalt, trachytes, and I believe, all igneous rocks.

Another point is its extensive tendency to become white externally, as if it were felspathic."

Fossil Bones at Frogmore.—A fragment of a leg-bone of an Elephant, another of Bos (?), a broken horn-core of Bos, and an antler of *Cervus intermedius* (?) have lately been met with near the New Garden, at Frogmore, in a

gravel-pit, which has been worked in the years 1858, '59, '60. They belong to Mr. Ingram, of the Royal Gardens, and were found at about the depth of fifteen feet from the surface. The upper soil for about four or five feet is sandy loam, then there is six or seven feet of red gravel, and three or four feet of washed gravel, in which the bones were found.

It may be a question whether the old bed of the Thames in ancient times may not have passed in this direction, or whether the river may not formerly have been much broader than at present.—Q.

THE GEOLOGY OF MALTA.—Dr. Gavina Giulia, a Maltese geologist, published a short time since, in the "Ordine" of La Valetta, some observations on the constitution of that island, which are not without interest. After establishing, with Professor Forbes, that the strata of Malta belong to the Eocene, or lower tertiary formation, he adverts to the fact that fossil remains of mammoth have been found on the island, including a piece of tusk seven and a-half inches in length. Now, as it is not to be supposed that such huge animals as the mammoth, the rhinoceros, and the hippopotamus, traces of all which have been found there, could have existed in so circumscribed an area as that of Malta, it is not to be denied that at a more or less remote period it must have formed part of the Continent, and must have been detached from it by some convulsion. The mammoth has never been found in tropical latitudes, and Professor Owen limits its existence to the northern hemisphere, within the forty-ninth and sixtieth or seventieth degree of latitude; but the discovery of the primitive elephant or mammoth at Malta shows that it must have been dispersed much farther south than has been generally admitted.

MAMMALIAN REMAINS.—About thirty-eight years since, *i. e.* 1803, the greater part of a skeleton of an elephant, with teeth and tusks, and teeth and many bones of a rhinoceros were found "embedded in loam, in the midst of an extensive accumulation of gravel," at Petteridge Common, Surrey. (See Mantell in Brayley's "History of Surrey," vol. i., p. 129, ed. 1841.)

TOADS LIVING WHEN SHUT IN PLASTER FOR YEARS.—"M. Seguin" (says the "Medical Times"), "wishing to ascertain what amount of truth there is in the marvellous tales told of batrachians being found living within the substance of stones, has undertaken some experiments upon the matter. He enclosed some toads very firmly in plaster, and left them for years in the middle of these blocks of factitious stone. At various intervals he has broken some of these blocks, and has found a certain number of the toads alive. One of the animals had remained thus deprived of air during ten years, another twelve, and a third fifteen years. Two still continue enclosed, and as M. Seguin is very old, and fears that these two blocks may be lost to the purposes of science, he offers them to the Academy of Sciences, in order that it may hereafter test the truth of the phenomenon. M. Flourens announces on the part of the Academy its willingness to accept them, intending, after a verification of the dates of sequestration, to have the plaster broken in presence of a commission *ad hoc*."

WASTE OF LAND BY THE SEA.—It is stated by a recent able writer on this subject, in treating of the action of the sea upon its coasts, that on the coast of Yorkshire four yards a year is the rate of decay. This loss for one million of years amounts to no less than two thousand two hundred and seventy-two miles; and even at one yard of annual loss, Yorkshire must once have extended five hundred and sixty-eight miles further eastward than it now does.—J. J.

NAGASAKI COAL MINES.—Her Majesty's ship "Roebuck" has been cruising outside, testing the Japanese coal, and trying to find out where the principal mines are in this vicinity; she proceeded to Yeddo direct, to try and obtain permission from the Emperor to see the mines, and how they are worked, or could be worked, and if possible to make contracts for regular supplies. An engineer who is on board her states that from the appearance of the different

samples of coal he has had he is of opinion the Japanese, not understanding the art of mining, work indiscriminately for bad or good seams, thereby producing a mixture unfit for general steam purposes, but that there must be splendid coal in the country, if they will only allow of the aid of a little science in working the mines.—"China Telegraph."

ALTON MUSEUM.—SIR,—For the information of geologists visiting Selbourne, or any other place in the neighbourhood of Alton, I wish to state in the pages of your journal that the museum of the Alton Mechanic's Institution possesses a collection of local specimens deserving their attention. They are from the drift, the tertiary clay and sand, the chalk-marl, malm-rock, gault, &c. They are not yet fully labelled, but I shall be happy to give information respecting them to any one who may pay us a visit.

So much has been said of late in disparagement of local museums; they have so often—and too often perhaps justly—been styled mere collections of rubbish, that where their existence is known they may happen to be overlooked and neglected when they may really contain much that is worthy of notice.

I may add that the Alton Museum contains, besides the collection of local fossils, one representing most of the British formations; also others of British mammals and birds, eggs, and land and fresh-water mollusca, chiefly local.

Besides these there are small collections in comparative anatomy, conchology, mineralogy, &c., all of them sufficient for the illustration of lectures and of class-teaching.—I am yours, &c., WM. CURTIS.

ANCIENT INDIAN ARROW-HEADS.—SIR,—Throughout Canada various relics are turned up by the spade and the ploughshare which were in use among the most ancient inhabitants. These relics consist of Indian arrow-heads from one and a-half to four and a-half inches long, darts or spear-heads six to seven inches long, battle-axes or hatchets, gouges, and chisels, all being composed of various kinds of stone and of copper, but principally of flint and chert. Sometimes the larger implements are formed of limestone, greenstone, or schist, whilst the smaller, such as the arrow-heads, are formed of grey or fawn-coloured chert or flint, and more rarely of red and black slates, and white chalcedony.

On the sites of ancient battle-grounds the arrow-heads are ploughed up in tolerable numbers, but elsewhere isolated specimens are casually picked up. It is a curious fact that no arrow-heads are found in any of the comparatively modern Indian burial-grounds, but the stone gouges are sometimes met with, thus indicating the more recent origin of the latter.

If flint arrow-heads are encountered, with other relics of stone and copper, among human skeletons, I think it affords an evidence of the extreme antiquity of the latter, which may probably be coeval with the Celtic period of Britain Some of the arrow-heads are exceedingly smooth, whilst the majority are rough, with a number of facets, and seem to have been formed by chipping the flint, and are not dissimilar to the ancient flint weapons of the British Isles.—GEO. D. GIBB, M.D., M.A., F.G.S.

ERRATA IN DR. GIBB'S PAPER ON CANADIAN CAVERNS.—Page 132, 34th line, for *Banchette's* read *Bouchette's*. Page 162, 15th line, for *thousand* read *hundred*. Page 162, 31st line, for *mall* read *wall*. Page 168, 6th line, for *Mergan* read *Mingan*. Page 169, 15th line, for *Daric* read *Doric*. Page 173 (foot-note, 2nd line) for *Keep* read *Reef*. Page 174, last line, for *way* read *bay*. Page 217, 18th line, for *Bay* read *Bass*.

REVIEWS.

An Essay on the Causes of distant Alternate Periodic Inundations over the Low Lands of Each Hemisphere. By AUGUSTUS BERGH. London: James Ridgway.

There are some topics now under discussion and investigation by geologists which possess an interest even greater than any which have yet been worked out by any previous efforts. Colonel James, in some excellent articles in the "Athenæum," has shown that an evagation of the poles has not only been possibly caused by the projection and upheaval of mountain ranges, but that probably even this may be reckoned amongst those causes which produced the former higher temperature of certain regions of our globe which are now within the temperate and arctic regions. And more than one essay, too, has of late been written with a view to proving the possibility of periodic floods.

In the modest treatise before us some important facts and doctrines are brought under attention. "Inquirers," says our author in his preface, "in their investigations of the different strata would discover cliffs and bays in the interior of a country similar to those observed in their rambles along the line of sea-coast, and the same view of steep abruptness or escarpments, with vegetable and animal remains, in the interior as on the coast. Such discoveries would naturally lead them to consider that the whole country must have been submerged by the ocean at some distant period; and on further investigation they would find that these inundations have not only once occurred, but that at several distant periods the ocean had encroached on the land, and the land thus been covered by the ocean. New layers of rocks, sands, gravels, and other marine productions had been the means of producing, successively, newer strata and newer countries. The geologists would consequently arrive at the conclusion that all these changes of strata and animal remains presented to their view must have arisen from an overwhelming ocean."

Our author then endeavours, "by consulting the noble science of astronomy, to find a cause for these periodical disturbances and encroachments of the ocean; and his work consists of "considerations on the motion of the major axis or revolution and change of the line of apsides of the earth's orbit; its causes, and the effect produced in its orbital revolutions through the ecliptic from one hemisphere to the other, involving a certain number of years.

"Astronomers have observed that the line of apsides of the earth's orbit has a motion through the whole ecliptic; and it is observed that the major axis does not always point to the same star, or, what is the same thing, the earth is forced onwards beyond the perihelion point every year to a certain extent, at the rate of 61″.761, as is proved by observation of the stars. * * That part of the earth's orbit which is nearest the sun—the perihelion—is three millions of miles nearer than the aphelion, or most distant range of the orbit; and when the earth is at its perihelion point, it is (owing to the sun's force) carried more rapidly through that part of its orbit, that is, at the rate of about sixty-one minutes per day. This increased motion," our author considers, "must necessarily increase and accumulate the waters of the ocean in the latitudes of the southern hemisphere, where the direction of the forces has its chief action. In consequence of these forces, the ocean has so increased in mass that it extends from the Pole to about thirty degrees of south latitude.

"We also find that the southern continents and islands have their southern extremities worn into acute angles, while those of the northern are obtuse, further proving that the united action of the solar and perihelion forces has

caused such an accumulation of water in the southern hemisphere; while, on the other hand, we find in the northern hemisphere a considerably smaller amount of water, but a greater excess of land. If we divide the land and water on our earth into one thousand parts, we shall find that there are but two hundred and seventy-five parts land, and seven hundred and twenty-five parts water. In the southern hemisphere opposed to the perihelion, we find sixty-five parts of land out of two hundred and seventy-five, while there are four hundred and thirty-five of water out of the seven hundred and twenty-five parts; on the other hand, in the northern hemisphere, opposed to the aphelion, there are two hundred and ten parts out of the two hundred and seventy-five parts of land, and but two hundred and ninety parts out of seven hundred and twenty-five of water. Can such remarkable facts and such a great disparity be accounted for in any other way than as stated in our theory?

"As already stated, and being demonstrably proved, that the perihelion moves round the ecliptic in twenty thousand nine hundred and eighty-four years, we will, for example, divide this circle into four quarters of ninety degrees, each of five thousand two hundred and forty-six years; and also state the change and amount in degrees of declination through which the perihelion will pass, both north and south, for it is at these four points of declination (that is, the two extreme and the two middle points of declination) that certain dynamical effects are produced, which will most sensibly strike the reader.

"At present, in the year 1830, the longitude of the perihelion is about one hundred degrees, one minute, five seconds, or in about ten degrees, one minute, five seconds of Capricorn; if from this year we fall back some thousand years, say, from ten degrees, one minute, five seconds of Capricorn, to the first degree of Cancer, a period of eleven thousand and seventy-seven years, and take our starting point when the perihelion point had its place in the first degree of Cancer, in extreme north declination, we may conclude that the low lands in the northern hemisphere would be overwhelmed by the ocean, as is the case with the low lands in the southern hemisphere at the present day. It follows, therefore, that (relatively to the year 1830) it is now eleven thousand and seventy-seven years ago since the northern hemisphere was last submerged, or nine thousand two hundred and forty-seven years before Christ.

"The perihelion would then pass through Cancer, descend through Leo to the first degree of Virgo, where it would be at a middle declination of eleven degrees forty-five minutes north, when the ocean would commence descending either rapidly or gradually southward, and overwhelm the lands of the southern tropics, while the northern hemisphere would be becoming gradually dry, at the time of the perihelion passing through the sign of Virgo, and crossing the equator: this would occur five thousand eight hundred and thirty years ago, or about four thousand years before Christ.

"We may here remark the close agreement of our physical theory at this period with many Oriental traditions, and the records of the Jewish writers, and also with the description in the first chapters of the Mosaic account.

"This completes the first quarter of ninety degrees of the ecliptic, in five thousand two hundred and forty-six years of motion through the same circle.

"In commencing our second quarter, we find the perihelion crossing the equator to the first degree of Libra, the ocean descending and overwhelming the southern tropics, where the lands would be exposed to the force of turbulent floods; this commotion would continue while the perihelion was descending through Libra to the first degree of Scorpio, at eleven degrees forty-five minutes of south declination, and while passing through Scorpio, the rapid descent of the ocean southwards would then gradually subside, having continued three thousand four hundred and ninety-eight years, while the perihelion had been descending from the first degree of Virgo, in north declination, to

the first degree of Scorpio, in south declination, as stated above. This would occur about the period when the antediluvians would feel the effects of the floods, and be compelled to retire from the southern to the northern hemisphere; this would also seem to agree with the escape of Noah in his ark. This occurrence would happen, according to our theory, about four thousand and eighty-one years ago, or two thousand two hundred and fifty-one years before Christ, the period of the deluge.

"This discrepancy between our calculation and the scriptural chronology of two thousand three hundred and forty-eight years, may be readily accounted for, as we know not the date when the latter chronology was written, whether at the beginning, middle, or end of the deluge, an inundating period of upwards of three thousand years.

"After this period the inundating power of the ocean would gradually cease towards the southern hemisphere, but would still slowly flow, for several thousand years; in the northern hemisphere, at the same time, a gradual retiring of the waters would take place, and a greater comparative tranquility would ensue in both hemispheres, after three thousand four hundred and ninety-eight years of commotion. The antediluvians would at this period be busily selecting dry spots in the northern lands whereon to fix their habitations. * * * The perihelion would now continue to descend through Scorpio, Saggitarius, to the first degree of Capricorn, at extreme south declination, and the low lands would then be completely submerged in the southern, while the northern hemisphere would be left dry, as we now find it to be from experience. The ocean will continue slowly to retire from the low lands of the northern, and will as slowly advance in the southern hemisphere; which process will probably continue for about two thousand nine hundred years more.

"The perihelion has now passed from the first degree of Scorpio to the first degree of Capricorn, in three thousand four hundred and ninety-eight years—a period of submergence of lands in the southern hemisphere, but of a retreating ocean from the lands of the northern hemisphere; the perihelion having altogether descended through the three signs, from the first degree of Libra to the first degree of Capricorn, in five thousand two hundred and forty-six years, has thus completed the second quarter of ninety degrees, or half a revolution of the ecliptic of one hundred and eighty degrees, from the first degree of Cancer to the first degree of Capricorn, in ten thousand four hundred and ninety-two years.

"This period would be arrived at between nine thousand two hundred and forty-six years before Christ, and one thousand two hundred and forty-seven years of the Christian era (or relatively to 1830), five hundred and eighty-three years ago.

"The third quarter commences at the first degree of Capricorn, from which the perihelion will pass on to the tenth degree first minute fifth second of the same sign in five hundred and eighty-three years, which brings it to the year 1830 of our era; the longitude of the perihelion being then one hundred degrees one minute five seconds. The perihelion will now continue passing through the remainder of the nineteenth degree fifty-eighth minute fifty-fifth second of Capricorn, to accomplish which it will require one thousand one hundred and sixty-six years; it will move on, after this, through the sign Aquarius, to the first degree of Pisces, at eleven degrees forty-five minutes of south declination, in two thousand nine hundred and fifteen years, when the ocean will entirely cease flowing to the south, and begin to encroach on the northern hemisphere; and after having passed through Pisces, it will have traversed the whole four southern signs in six thousand nine hundred and ninety-six years, of which, up to the year 1830, four thousand and eighty-one years have already expired, so that, dating from 1830, two thousand nine hundred and fifteen years more must

elapse before this passage through the four disturbing signs can be accomplished; and thus no disturbances of any consequence have occurred since the last catastrophe, two thousand two hundred and fifty-one years before the Christian era, and none will occur till four thousand six hundred and sixty-four years after the year 1830, when the perihelion will approach the equator. It will then have passed, from the year 1830, about eighty degrees in four thousand six hundred and sixty-four years. When the perihelion approaches the equator, then the equilibrium of the ocean might possibly be violently disturbed, and the ocean itself encroach forcibly on the northern tropics, and cause much destruction, as we find was actually the case when last the perihelion passed over the equator, from Virgo to Scorpio, about five thousand eight hundred and thirty years ago. The perihelion having now moved over the three signs, from the first degree of Capricorn, Aquarius, and Pisces, in five thousand two hundred and forty-six years, completes the third quarter and extends to six thousand four hundred and ninety-four years of the Christian era, or, relative to the year 1830, will have advanced four thousand six hundred and sixty-four years into the future.

"The fourth quarter will begin with the perihelion and ocean passing through Aries, and overwhelming the northern tropics, similar to the last-mentioned crossing of the equator. When the perihelion point shall have arrived at the first degree of Taurus, at a middle north declination of eleven degrees forty-five minutes, the ocean will then overwhelm the northern lands, and so continue to pass on until the perihelion shall have arrived at the first degree of Cancer, at extreme north declination, when the northern hemisphere will have all its low lands submerged, all but its loftiest mountains covered by the ocean, as they were twenty thousand nine hundred and eighty-four years before. The perihelion will now have moved over the two last inundating signs, namely, from the first degree of Pisces to the first degree of Taurus, both of middle declination; the former of south, the latter of north declination: and this ends the fourth and last quarter of five thousand two hundred and forty-six years.

"Referring to future periods, this will extend from six thousand four hundred and ninety-four to eleven thousand seven hundred and forty-one years of the Christian era, or will have proceeded onwards from four thousand six hundred and sixty-four to nine thousand nine hundred and eleven years into the future. Then the perihelion point will have travelled from one hemisphere to another in ten thousand four hundred and ninety-two years, and round the whole of the ecliptic of three hundred and sixty degrees in twenty thousand nine hundred and eighty-four years.

"How often the two hemispheres of our globe have been alternately submerged and left dry in a tranquil state we know not; but we do know that these phenomena of the alternate inundation and retirement of the ocean will be repeated at the same periods, and from the same causes, so long and as often as it may please the Great Designer of our system. * * Geologists know how forcibly the surface of our earth has been disturbed by a tumultuous or inundating ocean at various and distant periods, as most of our strata testify in the most striking manner; and we may be assured that these periodical disturbances and inundations will be repeated as often as these forces approach the equator; this is evidently the period when these forces occur.

"It is when the perihelion point of the earth's orbit is ascending or descending near the equator, that the equilibrium of the ocean is much disturbed, and consequently inundation is the result. For instance: when descending from the first degree of Virgo, at eleven degrees forty-five minutes of middle north declination, to the first degree of Scorpio at eleven degrees forty-five minutes of middle south declination, through sixty degrees of the ecliptic, in three thousand four hundred and ninety-eight years; and the same occurs when the

perihelion is ascending through the opposite signs, from the first degree of Pisces, in eleven degrees forty-five minutes of middle south declination, to the first degree of Taurus, in eleven degrees forty minutes of middle north declination, through sixty degrees in three thousand four hundred and ninety-eight years.

"These two portions of the ecliptic amount to one hundred and twenty degrees in a period of six thousand nine hundred and ninety-six years, which may be strictly termed periods of disturbance and submergence of lands alternately in both hemispheres. This long period may appear as a misfortune, or even as a great evil, to man and other creatures, but we will show it evidently to be a real blessing and benefit bestowed by the Giver of all Good on his creatures.

"We have given a brief view of the two disturbing periods of three thousand four hundred and ninety-eight years of the ascending and descending signs, both north and south; we shall now endeavour to show what an ample compensation the Great Designer has bestowed on his creatures for the above comparatively short disturbing period of six thousand nine hundred and ninety-six years. A double amount of tranquility is given; no less than two hundred and forty degrees of comparatively tranquil motion of the perihelion in thirteen thousand nine hundred and ninety-two years round the remainder of the ecliptic, and free from any great catastrophe such as happened at the disturbing signs. How can we, but with the most grateful hearts, praise and thank our Creator for such a disparity in the order of His designs, so that it may benefit His creatures? We cannot but acknowledge this as a great boon and blessing when we take into consideration how the overwhelming ocean remodels and fertilizes these new lands; seeing, indeed, that we are already necessitated to ransack every part of the world for suitable manure, in order to prevent the utter exhaustion of the soil now under constant cultivation. Therefore, we ought rather to rejoice than bewail at these periodic catastrophes, which are more of a benefit than otherwise. We shall find we are highly compensated by a long period of tranquil repose, when we consider the difference between thirteen thousand nine hundred and ninety-two years and six thousand nine hundred and ninety-six years.

"We have given the time and place when and where the ocean is disturbed, enduring from first to last six thousand nine hundred and ninety-six years. We will now explain the periods of the motion of the perihelion through those signs of repose, as before stated. These periods endure, first, while the perihelion is passing through the four northern signs, from the first degree of Taurus to the first degree of Virgo, both in eleven degrees forty-five minutes of middle north declination, extending through one hundred and twenty degrees in six thousand nine hundred and ninety-six years; and secondly, through the four southern signs, from the first degree of Scorpio to the first degree of Pisces, both in eleven degrees forty-five minutes of middle south declination, through one hundred and twenty degrees in six thousand nine hundred and ninety-six years, and thus completing a period of comparative tranquility of thirteen thousand nine hundred and ninety-two years, through two hundred and forty degrees of the ecliptic; the two periods together give the whole revolution of the perihelion of three hundred and sixty degrees round the ecliptic in twenty thousand nine hundred and eighty-four years.

"In considering this long comparative tranquility of thirteen thousand nine hundred and ninety-two years, we are reminded how often we have noticed, in perusing historical, astronomical, and geological works, remarks by the authors, when referring to past ages, somewhat to the following effect, 'We cannot perceive that any material change has taken place from the earliest historical times, in the natural events that have occurred for the last three thousand

years, and we think these natural causes and effects are the same, past, present, and to come.' Forgetting that our last three thousand years have passed quietly along a parallel with the equator, and will so continue until the perihelion point shall arrive at eleven and three-quarter degrees of south declination, when its parallelism becomes angular, in which angularity the ocean follows towards the equator, and then our tranquility ends. But what are three thousand years of repose? Not one-fourth of the thirteen thousand nine hundred and ninety years. It may appear to us, because we have three thousand years of comparative quiet, that it must continue so; and so it will for perhaps three thousand years longer, after which, we may, with some degree of certainty, assure our friendly geologists that our tranquil state in the northern hemisphere will cease. It has about eleven thousand years of comparative repose, and has, as above stated, about three thousand more years to expect, after which posterity must think of travelling southwards, as the antediluvians had to do northwards about six thousand years ago; and no doubt our posterity of the northern hemisphere will be compelled to abandon their lands for the southern, as their ancestors were forced to do towards the northern hemisphere; for, as already remarked, in about three thousand years after the present, we shall have timely warning given us, by the gradual advance of the ocean towards the equator, and its ultimate inundation of our northern lands. Hence it is evident that these advances and retreats of the ocean uniformly in twenty thousand nine hundred and eighty-four years are the sufficient and chief great causes of the change, and of the otherwise unaccountable appearances which are presented to our view when we investigate the various strata and perceive these oceanic wrecks. What an ample and clear explanation is then afforded of the singular intermixture thus found of varied organic remains, of marine and land animals, vegetables, &c., and their amazingly varied matrixes and beds! These intermixtures, &c., clearly prove how often they have been turned over and over again; and how deposits have been alternately formed on land, in seas, lakes, or fresh and salt water, and they likewise confirm how often the perihelion has made those important revolutions, from which spring such momentous and surprising results, and which will necessarily produce the same effects *ad infinitum*."

The author repeats that he can perceives no great evil or misfortune in these physical changes, which are not abrupt, as timely warning is given for one thousand seven hundred and forty-nine years, while the perihelion is passing through Pisces, and the sciences of astronomy and navigation, with the art of ship-building will give our posterity every means of foreseeing and avoiding the danger.

In respect to the obliquity of the ecliptic, our author thus speculates. "If we treat it astronomically, we imagine that it might have originally had an angular expansion of forty-five degrees, or even ninety degrees, and constantly diminished to its present rate, or perhaps became less angular at the last catastrophe or convulsion of the earth's surface. On the contrary, if our speculations take a mechanical direction, we can imagine that the immense breadth of land of the Asiatic continent, with the immense masses of lofty mountains, formed by the chain of the Caucasian, Tartarian, and Himalayan mountains, might drag or pull over the earth's pole in an easterly direction, and become at once the meridian of both poles of the equator and ecliptic, which are about twenty-three degrees twenty-eight minutes apart, and if our earth had not this inclination, its pole would probably have been located at Baffin's Bay, for, according to the observations of Captain Sir James Ross, the magnetic pole was observed in seventy degrees five minutes seventeen seconds north latitude, and ninety-six degrees forty-six minutes forty-five seconds west longitude. With regard to the diminution of the ecliptic angle, we conceive

that atmospheric moisture, rain, wind, and torrents, reduce and lower the mountains, the torrents carrying away the debris, by means of rivers, to the seas, where it becomes levelled far out into the offing, and thus the mountains are gradually lowered, and the angle of the ecliptic as gradually diminished. Such is our opinion: it may be so, or not; it is quite hypothetical; and so may also be our opinion on observing the different inclinations of the axes of our planets, sun and moon included: they all incline more or less to the plane of their orbits, in an easterly direction, or towards the right hand, and that in a contrary direction to their orbital motions: perhaps we might except Uranus. How is all this to be accounted for? Can they have acquired this particular inclination when first launched into an orbit, and while in a more plastic state?"

After some remarks on the orbital motion of the sun and on the astral systems, Mr. Bergh turns to a topic of high importance, but which has been too much overlooked by geologists—the mobility of the ocean. First taking into consideration the rise of lands, he very fairly asks, "How could islands or continents be raised from the bottom of the sea, either gradually or suddenly, without displacing the same volume of water? and could such a displacement of ocean water occur without altering the level for some time? Land and sea cannot occupy the same space any more than other things." He then dwells again on his theory before expressed on the periodic transference of the ocean waters from one hemisphere to the other; and offers some remarks upon the inclination of the polar axis, the fixity of which he disputes, and remarks, amongst other proofs, that ancient cathedrals and old dial-plates are no longer in harmony with those of modern times.

In conclusion the author considers that, "In looking back to the last catastrophe, we have sufficient evidence of a violent irruption by the ocean, from north towards the south, which our earth's surface shows in the most positive manner, and whereof also the enormous size of the erratic blocks and the boulder deposit are no trifling evidence of oceanic forces. This disturbance occurred about four thousand or five thousand years since, and is no doubt the deluge related in Scripture two thousand three hundred and forty-eight years before Christ; and those we read of in history, such as the deluge of Ogyges in Attica, which happened about four thousand years ago (relatively to the year 1830); also the deluge of Deucalion in Thessaly, about three thousand four hundred years since; all recorded at different periods, but all no doubt referrable to the one general deluge narrated in Genesis, which latter differs from our calculation about ninety-seven years, a discrepancy of no moment in relation to a period of inundation of three thousand four hundred and ninety-eight years, as before mentioned.

"The next time the perihelion and ocean cross the equator, it will be towards our northern hemisphere, in the year six thousand four hundred and ninety-four of our era, or four thousand six hundred and sixty-four years to come. Such a remote period can but little concern us, when, after the lapse of one hundred and forty generations more, perhaps both our nation and the name of our country may be forgotten, and lie buried beneath the deep, probably for the next seven thousand or eight thousand years."

Such is a full abstract of the opinions of Mr. Bergh. For the present we put them before our readers without comment, because these and kindred subjects being now taken up by M. Ardhemar, Colonel James, and others, in a powerful manner will compel us hereafter to elucidate the subject in detail. We merely at present recommend these theories to the impartial consideration of our readers, expressing ourselves as dissentients, however, from the calculations which give only four hundred and fifty thousand years as the time clapsed between the granitic era of Mr. Bergh's tables and the present time.

Letter on the Rapid Choking Up of Poole Harbour. By PHILIP BRANNON, C.E. Poole: R. Sydenham, High-street.

Last year a letter was addressed to the quay trustees and corporation of Poole on the state of the harbour there by Mr. Brannon; the following extracts from which give excellent illustrations of the rapid formation of sand-banks along a costal line, and as having a valuable bearing on some points connected with the rapid formation of ancient sandstones.

After many years close acquaintance with the coast in the neighbourhood of Poole, the author is convinced that not only the bar, but even the whole of the sand-shoals are comparatively modern, and that their formation has taken place with great rapidity. His belief is that at the time of the Christian era the bottom was almost entirely of clay, ironstone, and other beds which now appear above the surface; and that not only was the harbour capable of being entered in a straight line south-east, but that over the site of the Hook there was free passage with a clay bottom below, precisely similar to that found on sounding in a line with it off Flag Head and the Iron Rocks. This state of things continued, as it appears to him, long after the Saxon times, and it is quite possible that there was no considerable formations either of sand-banks below high-water mark, or wind-blown dunes above it, until long after the twelfth century, and probably even as late as the fifteenth. The cause of the formation of the Hook, and at a still later period of the bar, was the rapid inroads of the sea on the coast eastward. As long as the sand-cliffs of the Branksome and Flag Head district stood southward of certain lines of bearing with the Isle of Purbeck, all the sand which arose from the ruins of the western cliffs was swept clear out to sea, and was deposited in the depths of the British channel. So soon, however, as the soft cliffs of that part were washed back within those lines of bearing, the sand brought down came more and more within the influence of the deflected and reflected currents or eddies between the ebb waters of the channel and those of the harbour; and according to the invariable result in such cases was deposited in a yearly increasing ratio within the area of a delta, of which North Haven formed the north side, the channel ebb the south-east, and the harbour entrance channel the west. When this bank increased so as to rise above low water mark, during the ebb, the off-sea-gales drove up the sand on the shore, and thence formed the lofty dunes of the "Sand Hills." At first the bank was probably quite in a line with High Horse Manger, and as late as Henry VIII. the author believes there was very little sand deposited on the site of the present Hook. Every inch that Flag Head retired, however, gave the channel waters power to force these sand-banks north-westerly a great many feet. This vast bank of sand originally was formed, or at least deposited, in its present position in little more than one hundred and fifty years, or between the reigns of Henry VIII. and Charles II., and that if any difference from this be the fact, it would be in favour of a much later and shorter period. But there will be no doubt as to the truth, when the following results are considered. Their significance, too, will be more clear, if we previously remark that during the period which has since elapsed, nearly two hundred years, the harbour of Christchurch, then deep, commodious, and of considerable capacity, has been entirely silted up and rendered useless, in the same way that Poole harbour will be, unless measures both energetic and prudent be taken.

The original direction of the entrance-channel was in the line of the baying in of the five fathom line, one and a-quarter miles south (magnetic) of Flag Head, and three quarters of a mile east of the northern red buoy, and bearing more than one and a-half miles east of the Handfast line, or in a direction

south-east midway between Old Harry and Lobster Rocks. And it appears that this must have continued till nearly as late as 1700, and that if not then, at least at no very remote date, that channel had a depth of above four fathoms. By this date, however, the eastern cliffs had been so far abraded as to bring the power of the channel waters to act energetically on the harbour ebbs, within the area of the present Hook, and by the middle of the last century the channel had wested more than a quarter of a mile, and its original bed became the one mile swashway, the swashway of Mackenzie, which long retained a depth nearly equal to the present entrance; and the easternmost point of the Studland sands was then cut off by the new channel, and became the point of the rapidly westing Hook. Ultimately the seventeenth century channel, after becoming the one mile swashway, was almost wholly obliterated, and now only a varying difference of a few inches greater depth of water serves to indicate the proximity of its site.

The eighteenth century channel is the one shown in Mackenzie's chart, and in order to bring the measurements to an intelligent datum, we shall call the line from Old Harry to South Haven the "clear line." We have seen that the original channel was more than three quarters of a mile east of this, and in a short period wested a quarter of a mile, or more, and the process of westing having once commenced has gone on, and is still proceeding at a continually increasing rate, each successive westing bringing a decreased depth, a superficial expansion and subdivision of the currents, a continually decreasing power of wash, and a rapid rolling in of the sands northerly into the bed of the remaining clear channel—the prelude to a mischief worse than any other, and which, when it once takes place, will be utterly incurable, namely, the silting up of the harbour itself, precisely as has already taken place with Christchurch.

This late or eighteenth century channel evidently had a depth of three fathoms, and perhaps much more. The current daily yielding to the westing continually became more curved, and afterwards scooped out the commencement of the present entrance. The power of wash thus diverted gave up the channel to silting, which itself continually reacted in throwing new force into westing. Notwithstanding, as late as 1784, during the survey of Whitworth, the depth was sufficient to excite little alarm, and to leave the attention of improvers wholly directed to the interior of the harbour, and the following year Mackenzie made his chart, giving ample proof of the state of the entrance then, and of its former line of bearing. This channel, by the Admiralty edition of Mackenzie, corrected by Sparke in 1829, is shown to have been still in existence, and even then to have retained a depth of two fathoms. The entrance thus remained thirty years ago nearly half a mile east of the clear line, with a depth of two fathoms, and that the progress of change up to that time did not appear so threatening in its rapidity is evinced by the fact that the talented Mr. Rendle, in his surveys and plans, both antecedent and subsequent to Lieut. Sparke's survey, directed his chief attention to the interior of the port.

The present channel is therefore obviously the result of agencies acting with such force and rapidity that in twenty years alone, between the surveys of Sparke and Sherringham, the channel had wested half a mile. The current completed the excavation of its present course across Studland sands, and brought it within or west of the clear line, cut off the bar from the Milkmaid Bank, and united it to the Hook, of which it is now become really the extreme horn. The noble and direct channel of the eighteenth century was in this way converted into the one and a-half mile swashway of only six feet depth; and thus the entrance to Poole harbour, once most direct, easy, and safe in access, became not a channel at all, but an expanded shallow, tortuous, difficult, and dangerous.

The shallowing and westing are now increasing with such speed, that they may be measured almost from week to week, and eight feet is probably all that can be secured at low water spring-tides; this will be speedily decreased to seven, then to six or five feet, and the trifling swashway, the memorial of the fine channel of 1820, will fill up and be obliterated.

The silting up of the harbour is almost wholly caused by the inwash from the sand-shoals of the Hook in the last few years. This result will follow in more rapid stages so soon as the sand-banks, which are northing as well as westing, shall have northed to a certain line across the mouth of the harbour. Towards this line the sands have moved in twenty years a quarter of a mile in the three fathom depth. For a time the ratio of northing will be possibly a retarding, and not an accelerating one, but in a very few years—perhaps thirty, or less—the bar will have advanced northerly to a line with the sunk vessel. For a century, and slightly for two centuries, every tide had taken in sand, but a portion was swept out again. But during the last fifty years every flood tide has taken in increasing quantities of sand, while no ebb tide ever takes any out. When the bar shall have passed a certain line, the sand will come within the direct influence of the prodigious velocity and power of the water rushing into the confined and narrow entrance, and will move in great quantities; and although a little may be forced back on the bar at the ebb, a great deposit will be made internally, and one of the finest harbours of Great Britain will be converted into a mere marine marsh.

To remedy this, Mr. Brannon proposes to restore the entrance to Poole Harbour to a straight channel of four or five fathoms depth; or greater if desired. The indispensable work for which would be a breakwater or pier from South Haven, to secure a new channel coincident with the ancient one, or between that and the eighteenth century openings.

The Geology of Weymouth and the Island of Portland. By ROBERT DAMON. London: E. Stanford, Charing Cross. 1860.

A writer in the "Athenæum" a short time since described the requisites of a guide-book as consisting in having the matter good and reliable, and well arranged, without any superfluity in the shape of fine writing or grandiloquent descriptions. It is certainly something to have all the materials so well arranged that you know where to turn at once for anything you want to find; and so far as reliable matter and this principle of arrangement are concerned, Mr. Damon's "Geology of Weymouth" is a model guide-book, and no tourist or amateur geologist should visit the beautiful neighbourhood in which he resides without it.

The illustrations are well selected, and generally well executed, something to say of a geological book illustrated by wood engravings; for the generality of these in works on that science are execrably bad, as any one may be satisfied by turning even to some of the works of our best authors. The printer, however, has done nothing towards showing them off.

Mr. Damon seems to have taken great pains to produce a useful and good result, and we hope the sale of his little book may bring the appropriate reward.

THE GEOLOGIST.

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THE GEOLOGY OF THE SEVERN VALLEY RAILWAY.

A SKETCH BY

GEORGE E. ROBERTS.

AUTHOR OF "THE ROCKS OF WORCESTERSHIRE."

DEEP cuttings and long tunnels are regarded by railway-contractors as things to be avoided, though lessons of the greatest instruction are derived from them by the student of geology. But as safety in transit demands the easiest gradients, and a line as straight as possible, the lesser inequalities of the surface have often to be cut into, so that no insignificant part of geological teaching is derived from railway-work. And oft-times a way that puzzles the contractor to make "good," or a hill-slope that, lacking knowledge of its springs, he has cut into only to see it slip continuously upon his line, are great aids and helps to comprehending the natural formation of a district, and so, a contractor's poison becomes a geologist's meat.

There are many such instructive points upon the Bridgnorth railway, which after briefly noting I hope will be looked at with pleasure by observers. In the mere name of the line there is a certain spice of geology—"The Severn Valley;" its whole course being along a narrow and in places deep valley, scooped out like a channel between England and Wales. Perhaps everyone knows that at no very distant time, the tide which now laves the beaches of Cheshire, came rolling down this arm of the Irish sea, bringing shoal sand, and banking it in places about its course, and rolling the pebbles along its current till beaches, as well marked as those of Rhyl and Llandudno, were laid in lines parallel with the flow. Everybody sees evidence of this in the gravel-beds which lie upon the red sandstone in so many places in these border-counties, and specially to be noted in the neighbourhood of Bridgnorth, at Acleton and Worfield, where *Terebræ*, those slender trumpet-shells so abundant on the Welsh coast, may be picked up in sand; at the Knowl—more firm sand, by

the bye, than gravel, and at Upper Arley, where there is a grand cutting through thirty feet of these gravel and sand deposits, on the railway, worth going miles to see, even if the collector of ancient life-remains unsuccessfully searches for the common whelk (*Buccinum undatum*), which *has* been found with fragments of other sea-shells among the smaller pebbles, just as they were left by a retiring wave. And here, too, in lines of shoal-sand, exposed in the face of the cutting, may be seen black "pockets," partly filled with carbonaceous matter, to wit, the remains of drift-wood, and perchance of sea-weed, cast on shore by strong gales. All this is very easy to understand, especially to those who pay regular visits to the coast, and note the ever-active agencies at work there, building up in one place, and throwing down in another; heaping together pebbles and sea-drift upon the beach, and deeply-mining, with the battering stroke of great waves, the rocky faces of the cliff.

But these modern inland evidences of a former coast-line, though useful as teachers, are very great hindrances in our attempts to make out the real constructive features of the district, for they cover up all the older beds, all the rocks whose decomposed and disintegrated layers give us the deep rich soils of our wheat-lands and gardens—rocks older in time than themselves—mineralized beds of water-sediment containing shells and fishes and corals, treasures laid up of old to bear testimony to us; so that we who would learn of them have thanks to give to railway-work for having in many places cut through this coverlid of gravel and sand down to these older rocks, and introduced to us local differences in their natures, which otherwise we should have been ignorant of. And in every place where this is the case, both along the line of railway and elsewhere, we see one notable difference between the gravel-beds and the underlying old rock; the gravel is in flat, level measures, while the sand, or lime-rock, uptilted by volcanic action, dips more or less from the horizontal. Therefore if geology did not teach us by evidence elsewhere that millions of years elapsed between the deposition of the New Red Sandstone, as a sedimentary accumulation, and its concealment beneath the slowly-laid gravel and sand-drift of the Channel, our senses would give us the notion of some great lapse of time, long enough to alter the whole physical condition of the district, and to permit the slow elevatory movement to die away in a period of quiescence and repose.

The cuttings along this line of railway being one great lesson-book, we must, in studying it, begin with the earliest pages—that is, with the bed of hardened water-sediment (called rock by us in common parlance), laid the earliest in time; and to see this, Bridgnorth students of this marvellous science must betake themselves to Benthall. I envy them the shortest day's work in that wonderful treasure-house; for the proximity of the line to that great limestone-cliff of Silurian rock affords great scope for study, and advantages of collecting relics of primeval life almost beyond any other place. Gain the top of the "Edge" as soon as you can, and make your way

along the line of old quarries that runs parallel with the flow of the river beneath. Everywhere through these quarries lie spoil-banks of debris and fragmentalia, heaps of rubbish to practical eyes, but treasure-houses of much value to geological ones, for I have but to stoop over them—putting on my best eyes for the work—and I can pick up shells, and corals, and zoophytes, aye, and shelled insects too, (Trilobites) sea-woodlice, whose hard enduring shields, protecting them in life, have been mineralized into panoply of stone, that shall tell me a certain and reliable story of their habits and position, when each was tenanted by a living, moving, feeding creature. Let those of your party who choose look after the thousand and one detached fossils which are strewn over the ground; but the lover of antiquities shall come with me, and study a slab whose surface shall be *al relievo* with life-remains: in truth, a very old page of earthly history, writ in strange, uncouth, almost undecypherable characters. To this a Persepolitan cylinder, graven with arrow-headed glyphs, is a record of yesterday; to this the tablets of Seth, on which were written the wisdom of the pre-delugian age, are of modern date. No "Open Sesame!" of Professor Fehretmout or Dr. Dryasdust will open to the day and reveal the secrets of these times, for here is a chronicle of Nature, writ so long ago that

> "Mountains have arisen since,
> With cities on their flanks."

No mere poetical saying, but a sober scientific fact.

The great outcrop of these Silurian beds at Benthall is continued westward to Wenlock, and there, in the "Edge," developed to an extent which has caused this division of Silurian strata to be known everywhere as the Wenlock series. Some of its layers are little else than a mass of life-remains, corals especially, of which about forty species may be found with very little search. There is no other exposure of this old rock elsewhere along the course of the line: more modern deposits everywhere cover it up.

Next above the sediment of the Silurian ocean lie the sandy and brashy beds of the Old Red Sandstone lagoons; dark-red rocks, with bands of compacted fragmentalia, locally known as cornstones. There is an open cutting through a dome-shaped protrusion of these, a mile south of the Victoria-bridge, but the line hugs the Severn too closely to permit a further acquaintance with this, the typical rock of Herefordshire. The Old Red, however, approaches Bridgnorth as nearly on the west as the Leasowes, Old Hay, and Harpswood, from which places it has the surface all to itself westward through Corve Dale to Wenlock Edge. And a very fertile land that surface is, for the cornstone makes notably good wheat-land. In our local development of this red rock, so distinct in appearance from the blue limestone, there are no traces of shells or coral, though doubtless both were abundant in the seas of the age. We prove, however, the existence of fish in that water, for both in cornstone and sandstone we

find the hard china-looking defensive shields of some curious species. Those who care to know what these are, and to search for them in Old Red quarries at Chetton, Glazely, and Overton, will find them described in my "Rocks of Worcestershire" (London: Masters; 1860). Upon the Old Red Sandstone lie the Carboniferous beds—the next accumulation of time. The line near Linley cuts through some fresh-water (?) deposits of this age, in which are bands of hard cream-coloured limestone, containing estuarine bivalve-shelled crustacea (*Cypris* or *Cytheridæ*), and very tiny teeth, hard, black, and shining, of small predatory fishes. The outcrop of rock crossed here by the line extends as a belt of surface varying in width from two hundred yards to a mile, due south, but does not again approach the river-channel until we reach Hampton's Load, where low hills, shutting in the channel westward, introduce us again to the poor, dirty clays that lie above the coal.

From the ferry to the Victoria bridge the line has its course through deposits of this age, though in some places—chiefly on the banks opposite Upper Arley—a thickness of twenty to thirty feet of Severn Strait gravel and sand obscures the Carboniferous measures. Here, however, the line is carried by a cutting deep into the underlying yellow sandstone rock, and a very instructive section of that important member of the coal-rock group is obtained. Beyond the crossing of the river there is an extension of these coal-beds into Eymoor Wood, in fact the picturesque cliff of Seckley Rock points clearly to related measures in the hills eastward of the river.

A mile south of the bridge we run into Old Red, aforesaid, at the Hill Wood. Half a mile of cutting through this and then coal-measure rock shuts in the line, resting on natural position against the dome. For two miles this, once again along the course of the Severn Valley Railway, forms its surface, very greatly to the pleasure of the geologist, for here is a notable exposure—thanks to the railway-work—of its fossiliferous measures. Several layers of sandstone and shale with plant-remains, may be noticed in the banks on each side; but at a point parallel with Northwood Cottage, a pretty white house fronting the river, we run through a cutting of grey shales, with brown-black seams of fern-coal, every layer of which contains fossil plants, in greater or less abundance. Indeed, if a braken bed had suddenly been overwhelmed by a flood, and the ferns buried beneath the muddy sediment just as they grew, no richer deposit of plants could have been got together. Ferns chiefly, belonging to the genera *Pecopteris*, *Neuropteris*, *Sphenopteris*, and *Dictyopteris*, of which latter genus, (a noticeable one among the group for having reticulated venation), a species recently discovered in a continuation of these measures a mile north of this spot, is here very plentiful. This has been described by Prof. Morris, under the provisional name of *Woodwardites (?) Robertsi*,* but it must be identical with a *Dictyopteris* of the Dresden coal-field.

* Geol. Soc. Journ., vol. xv., p. 82.

This brown fern-coal should be carefully examined, for any thin films, natural shavings of the bark, which will show the cells, or vessels, or tissues of these ancient plants. A similar bed, belonging to the lower coal-measures of Nova-Scotia, has yielded many instructive fragments of this kind;* and we are indebted to the coal-measures of Moscow for others.† Let us search for them nearer home.

A great deal of rock has yet to be removed at this place, so that many rare and beautiful plants will be brought to light, and, let me hope, rescued by geological students, induced by this sketch of its fossil wealth to pay the bed a visit, before the treasures are carted away to other parts of the line. Mr. Edward Baugh, of Bewdley, has a noble collection of these fossils, obtained from this and near-lying places.

Above the coal-measures are other red rocks, called Permian. These are of special interest to the geological observer, because they evidence, by their mineral constituents and fossil remains, the appearance and productions of the surface at the close of the first great division of ancient time, the Palæozoic epoch.

Astley-Abbots is on these sandstones, which there lie against the hilly coal-measure ground of Tasley, a line continued due south to Oldbury and Chelmarch, with the same relations of natural position to the westward band of coal-rock. Plants, allied to palms of the tropical zone are the clearest indication preserved to us of the flora of this age; but I do not think any have been found in railway-cuttings through the Chelmarch country. However, when the line is opened, I hope Alveley will be reached by the "Bridgnorth Naturalists' Field Club," and the quarries near the village, and at Shropshire farm examined and studied, both for the character of the rock, and the fragments of fossilized palm-stems that occur in it.

To learn the next page in our rock-volume, we need not stray far from Bridgnorth. Unfruitful of fossils, and unstable in quality as the New Red Sandstone is, it has so much to charm us in its picturesque water-worn rocks as exampled at Quatford and Stanley, and in the deep dells and valleys about Apley and Badger, that I question whether other systems, though richer in relics of ancient fauna and flora, have an equal place in our regard. No doubt the question will be asked by many enquiring minds—looking up at the deep cutting into New Red Rock at the Knoll, or at the still greater thickness of the same measures (the Lower Soft Sandstone), upon which the castle stands, and through which the tunnel takes a circuitous and utterly incomprehensible way—why is it that no life-remains are found in these rocks? Sediment of a former sea they undoubtedly are; could that water have been a lifeless barren element? And to these natural enquiries we can return no certain answer; though the presence of oxides in the old water to an extent sufficient to colour the whole of its depositions a ferruginous red, seems enough of itself to explain

* Dawson's Sup. Acadian Geology, p. 25, and Geol Soc. Journ., vol. xv., p. 626.
† Memoires de la Soc. Imp. des Nat. de Moscou, tom. xiii., p. 39.

why if shells and fish and crabs lived therein, their remains should after death be destroyed by such mineral agencies, in every condition of the surface antagonistic to conservation. But whether the whole bed—of no mean thickness be it remembered, and evidencing a great lapse of time—can furnish no trace of its former life, is yet to be proved; and I do not by any means advise local observers to give up search, especially in the lighter-coloured strata.

This lowest member of the rock-group, known as New Red, is the highest, most recent deposit—excepting the gravel of the Severn Strait age—crossed by the railway near to the town.

But at Mount Pleasant, south of Bewdley, the line is taken by tunnelling through the central conglomerate, or pebble-bed rock, which forms the commanding fort of Pendleston, or the High Rock, near Bridgnorth, and at Wilden, two miles south-east of Mount Pleasant, the upper soft Red Sandstone is cut into by an excavation, the rock-walls of which tower to the height of sixty feet above the line; while at the terminus of the railway, near Hartlebury, the cuttings show that the ascending order of geological deposits, which, since we crossed the dome of Old Red at the Hill Wood, north of Bewdley, we have rigidly kept to, has brought us up to the Waterstones, a sandstone rock, easily distinguishable from those we have seen, by its containing small shining scales of white indestructable mica.

I hope no one will look upon this sketch, which an intimate knowledge of the Bridgnorth district enables me to give, as exhaustive of the subject, or other than a general introduction, upon the broadest basis, to the geological history of that locality. And among the lessons learnt from it, this one I trust, will be the longest remembered—that man's enterprise is an instrument in the hand of the Creator, for furthering knowledge of His works, and displaying to us, in rock-cutting and tunnelling, the operation of His hands—whispered truths of hidden and secret nature—"whether we will hear them or whether we will forbear!"

ON NEW BRACHIOPODA, AND ON THE DEVELOPMENT OF THE LOOP IN TEREBRATELLA.

By Charles Moore, F.G.S.

At the time of the commencement of Mr. Davidson's monograph on British Brachiopoda, published by the Palæontographical Society, little had been done towards their systematic arrangement and classification. Sowerby had figured many species; but valuable materials were accumulated, and many new forms waiting for description in the cabinets of different collectors, which have since been done justice to in the above valuable publication.

At the time referred to but fourteen species, of the genera Lingula, Orbicula, Spirifer, and Terebratula had been figured from the three divisions of the Lias, but I had succeeded in discovering twenty new species in the Middle and Upper Lias of Somerset, including the genera Thecideum, Leptæna, and Crania, genera which had been previously unnoticed in these formations.

Of the genus Thecideum, the Middle Lias of Somerset yielded me three species, viz.. *T. Bouchardii*, *T. triangularis*, *T. Moorei*. In this formation they are rare, and when found are almost invariably attached to the plicated exteriors of *Rhynchonella serrata* or *R. tetraëdra*. On a specimen of the former shell, which has been figured by Mr. Davidson, there are seventeen examples belonging to the three species I have mentioned.

The Upper Lias of the west of England, especially in the neighbourhood of Ilminster, rarely exceeds in thickness ten or twelve feet, and is sometimes reduced to four or five feet. In the clays at its base the genus Leptæna occurs of several species. About the time of their discovery, one species, the *Leptæna liasiana*, had been found in France, which I had sought for in vain in this country. During a visit paid me by Mr. Davidson, as we were approaching a section of Upper Lias, he remarked how interesting it would be to find the French species in association with those I had already discovered. To our great delight the first object that presented itself to me was a little shell, which rendered the *L. liasiana* a British species. I have never found more than four specimens, so that it is very rare.

Before the publication of Mr. Davidson's "Appendix," in 1853, I had examined the Inferior Oolite of Dundry for Brachiopoda, and found there eight species of Thecideum, five of which were new, together with the *T. Bouchardii* and *T. triangularis* I had previously obtained from the Middle Lias,, and *T. Deslongchampsii* of the Upper Lias. The same locality also furnished me with a series of little shells, which threw light upon some I had previously found in the Upper Lias, forming a passage between the Thecideidæ and the Terebratulidæ, for which the sub-genus Zellania has been created. These, with a little shell named *Spirifera oolitica*, were shortly noticed by me in Mr. Davidson's "Appendix," but have since been figured and described in the Journal of the Somersetshire Natural History Society for 1854. At the time of its publication I was convinced that the discovery of many new species of Brachiopoda might be expected from a continued investigation of the secondary formations; and it is to new species found since I now desire to direct attention.

On Hampton Down, near Bath, there are extensive excavations where the Great Oolite was formerly largely worked. Latterly a new quarry has been commenced, and in order to reach the workable beds of freestone, the following beds in descending order had to be passed through :—

	Ft.	In.
1. Thin bands of freestone	4	6
2. Brown raggy coralline bed	9	0
3. Compact grey limestone	5	0
4. Workable beds of great oolite	20	0

The grey limestone (No. 3) contains many organic remains, but owing to its hard and intractable character few are to be extracted entire. In its weathered edges may be seen the *Lima cardiiformis*, *Trichites*, *Lithodomi*, and many corals.

The raggy bed (No. 2) is very incoherent, and appears to have been an ancient coral reef, it being in great part composed of corals and sponges. Intermingled with these branching corals are myriads of beautiful organisms, which, from the unconsolidated nature of the bed, are easily extracted. They consist of dismembered ossicles of starfishes, the plates and occasionally the bodies of the Bradford Encrinite *(Apiocrinus Parkinsoni)*, spines and shells of Echini, Oystrææ, and other mollusca, and with them very many specimens of a small Brachiopod, which has hitherto been considered the young of *Terebratula maxillata*, but which I shall presently show is to be referred to *Terebratella*.

The Brachiopods obtained at Hampton consist of *Terebratula cardium*, *T. coarctata*, *T. digona*, *T. hemispherica*, *T. maxillata*, *Rhynchonella concinna*, *R. obsoleta*, *Crania antiquior*. It will thus be seen that only three genera of Brachiopods have hitherto been known in the Great Oolite, and the bed under consideration. To these I have now to add four other genera, viz., Terebratella, Terebratulina, Thecideum, and Zellania.

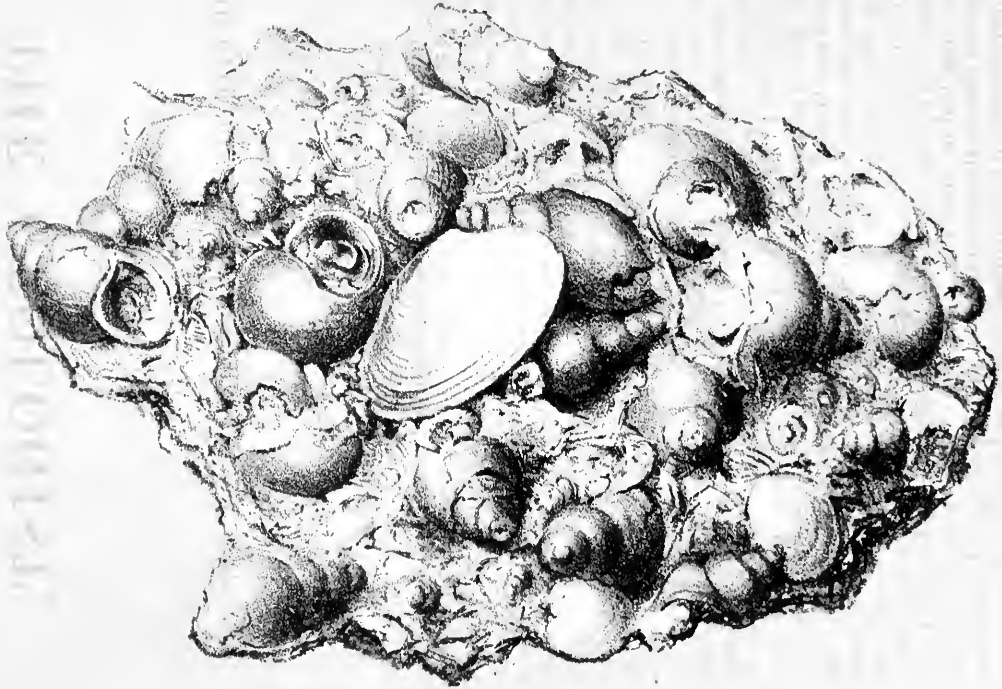
Terebratula maxillata. Sow. Pl. xiii., figs. 6, 7.

The adult form of this shell is found at Hampton, though usually either in single valves, or in a crushed state. The young ages of this shell are externally hardly distinguishable from the *Terebratella Buckmani*, described below. It differs from the latter shell in its beak being more truncated, and the foramen more rounded; it is also usually longer than broad, a character it loses when more adult. Internally the generic difference is at once apparent, as this shell possesses a short reflected loop, which in Terebratella is doubly attached.

Terebratula hemisphærica. Sow.

A pretty little shell, originally figured by Sowerby under the name of *Terebratula hemisphærica*, is not uncommon at Hampton Cliffs. This was subsequently removed by D'Orbigny from that genus, and placed with the Terebratellæ; and on the authority of the species to which I now refer, that author carried the latter genus into the oolites, in which he was followed, although with some hesitation, by

Pl XII



SLAB OF BETHERSDEN MARBLE (WEATHERED), WITH PALUDINA FLUVIORUM & UNIO ANTIQUA

In the Collection of William Harris, Esq.re F.G.S. of Charing.

S. J. Mackie del.

Mr. Davidson. It will be seen from what follows that two species at least of Terebratella are to be found in these beds; but when D'Orbigny placed the *Terebratula hemisphærica* in this genus, he could not have seen its interior, which, in several examples I possess, have the short and simple loop of Terebratula, and the shell in question will therefore have to return to its original position.

TEREBRATELLA.

TEREBRATELLA BUCKMANII. Woodward, MS. Pl. xiii., figs. 1-5.

Shell generally a little longer than wide, rounded in front, and tapering to the beak; valves moderately convex; beak short, very slightly incurved and truncated by a foramen, surrounded in part by the extremity of the beak, the umbo of the dorsal valve, and two small labral deltideal plates. Internally the adult shell is provided with a doubly attached loop, the first pair of lamellæ extending considerably before becoming reflected to form the loop. Shell structure punctuate. Dimensions of the largest example hitherto observed: length, $3\frac{1}{2}$ lines; width, 3 lines; depth, $1\frac{1}{2}$ lines.

Obs.—I had collected a considerable number of these little brachiopods from the oolite of Hampton Cliffs, under the idea that they were the young of the *Terebratula maxillata*, my object being to prepare dissections showing the loop of that species. I was much interested in finding in the example I first opened that it could not belong to the young of that genus, although outwardly it is almost undistinguishable from it. The difference in the loop proved it to be a true Terebratella. My observation does not show that it attained larger dimensions than those mentioned, but it had then assumed the character and development peculiar to the loop which characterizes the genus to which it is referred. In an early stage of my examination, modifications in the shape of the loop were noticed, and observations extending to several hundred specimens resulted in showing the curious changes effected by age in the form of the loop, which may be seen by referring to plate xiii., figs. 2, 3, 4, and 5.

The first stage of development I have been able to observe is sketched in fig. 2. Therein it may be perceived the two first lamellæ are united to the hinge-plate, and to a free rudimentary mesial plate, which is, in fact, the first origin of what at a later period becomes a mesial plate. In this state it is free, and does not touch the bottom of the valve, although when viewed in profile spines may be seen passing downwards, which afterwards join the mesial septum.

The loop has not yet been formed, but a plate projects between the lamellæ, and appears as if longitudinally split to a certain depth in the centre.

The second stage is exhibited in fig. 3. In this we find the two lamellæ with the rudimentary plate as in fig. 2, and, besides, the origin of the reflected portion of the loop, presenting in this first stage of its development but a very small and rudimentary aspect.

The third stage may be observed in fig. 4, where the different parts are still more developed, but the mesial plate has not yet reached the bottom of the valve.

By gradual changes we are thus conducted to the fourth stage, fig. 5, where the loop has attained its complete development. The central plate, which was freely suspended in the shell before, has now reached and become soldered to the bottom of the valve; the first pair of lamellæ are still attached to its upper sides, and the reflected portion of the loop has become fully developed, the extremities facing the front of the shell being considerably prolonged, as is seen in fig. 5 of our plate. Numerous long spines also project from the outer edges of the lamellæ and loop, giving to the interior a very peculiar appearance.

The subject of the development of the internal calcified supports in brachiopoda is of considerable interest, and much may yet be learnt by a careful study of recent specimens of this class. The importance of attention to the subject is the greater when it is remembered that the classification of many of the brachiopoda depends more upon internal than external form, and that had the different stages of development shown by the *Terebratella Buckmanii* been observed under other circumstances, or from beds of different geological ages, each would probably have been constituted a distinct genus.

The *Terebratella Buckmanii* is the prevailing shell at Hampton Cliffs, and many hundred specimens have passed through my hands. It has before been remarked that the young of *Terebratula maxillata* also occur at Hampton, though this species is comparatively rare. It requires considerable experience to determine by the exterior to which genus the different shells belong. Both possess the same contour, and are strongly punctuate. In general, however, the *Terebratella Buckmanii* may be distinguished by a dark longitudinal line in the centre of the ventral valve, due to the mesial septum, and by the characters previously noticed when speaking of *Terebratula maxillata*.

It is due to my friend Mr. Woodward I should remark, that whilst my investigations on this shell were in progress, having been the means of conveying a series of them to him, he noticed it to be a Terebratella; and in a communication to Mr. Davidson suggested the specific name of *Terebratella Buckmanii* for it, which I have much pleasure in adopting.

TEREBRATELLA FURCATA. Sow. and Moore. Pl. xiii., figs. 8-10.

Terebratula furcata, Sow.; *T. orbicularis*, Sow.; *T. cardium*, Lamarck.

Shell small, rounded—both valves moderately convex; valves coarsely plicated, varying in number, and may be seen on the inner side, bifurcating occasionally; surface punctuated; beak truncated; foramen large; loop doubly attached.

This little shell was originally figured by Sowerby under the name

of *Terebratula furcata*, but subsequently he considered it might be the young of *Terebratula orbicularis*, Sow., the *Terebratula cardium* of Lamarck, in which he was followed by other naturalists. The *T. cardium* is found at Hampton Cliffs, in association with this species, and from the close resemblance it bears to it, might reasonably be considered its young form. Having succeeded in opening a beautiful example showing the interior of the shell, the double attachment of the loop proved it to be a Terebratella. The interiors may be seen by referring to pl. xiii., figs. 9, 10. The profile shows the upper lamellæ of the loop, after leaving the hinge-plate to be possessed of a pair of crural spurs. About the centre of the shell the lamellæ are attached to an elevated mesial septum. The front of the loop, as well as the reflected portion, is broad; and projecting towards the opening of the shell, and on the under side of the lamellæ, are a number of closely set spines. This shell is very rare at Hampton, owing to which I have been unable to make any observations on the development of the loop as in *Terebratella Buckmanii.* The fact of the shell under consideration proving to be a Terebratella at once suggested the possibility that *Terebratula cardium* might also belong to that genus; and I learnt from Mr. Davidson that he could not speak positively on this point, as the shell from which his interior was figured was not clear of the matrix, and only partially exhibited the loop. I have taken much trouble to establish the correct position of the *T. cardium*; and after the examination and dissection of many specimens, am able to say that the loop, as figured by that gentleman, is correct. This species must therefore remain in its present position, but the examples supposed to be its young forms will have to be placed under Terebratella; and, retaining Sowerby's original specific name, must be called *Terebratella furcata.* Two species of this genus are therefore added to British Jurassic beds, and the *Terebratula hemisphærica*, which was supposed to represent it in this age, removed. I have obtained a portion of the interior of a small brachiopod; showing a mesial septum, from the Upper Lias, near Ilminster, which convinces me that the genus may also be found in that formation.

Terebratulina.

Terebratulina radiata. Moore. Pl. xiii., figs. 11-14.

Shell small, nearly as broad as long; thickest near the umbo, and thinning gradually to the front and sides; front rounded; valves convex, flattened, with numerous fine striations; foramen large, rounded; area flattened; the exterior of the ventral valve shows a mesial depression, with a corresponding elevation in the interior of the valve. The loop is short; after passing the crura it forms a semicircular ring, slightly thickening in its centre.

This little shell is not uncommon in the oolite of Hampton Cliffs, and is the first Terebratulina recorded in British Jurassic beds. In

its external form it is not unlike *Terebratulina subradiata*, but it does not, in any example I have seen, attain one-tenth the size of that species. It is also more circular, less convex, and has a more pronounced sinus in the ventral valve than that shell.*

The *T. radiata* appears to have continued upwards from the Inferior Oolite, as I am unable to separate from it some specimens I have obtained from Dundry, near Bristol, the only distinction being that the latter assume a more elongated form, which is to be observed by comparing pl. xiii., fig. 14 (from Dundry) with figs. 11, 12 (from Hampton Cliffs).

ZELLANIA. Moore: 1854.

Three species of this genus were described by me in the Transactions of the Somersetshire Natural History Society, for 1854; one being from the Upper Lias, the other from the Inferior Oolite of Dundry. To these I have to add another from Dundry, and a fifth species from the Oolite of Hampton Cliffs. The genus also occurs in the Coral Rag of Lyneham, Wilts. Its range is therefore shown to extend from the Upper Lias to the uppermost beds of the Oolite.

ZELLANIA GLOBATA. Moore. Pl. xiii., figs. 15-17.

Shell very small, globose; valves moderately convex, rounded at sides and front; exterior surface smooth; beak slightly projecting; foramen encroaching on both valves, rounded.

Obs.—I have five examples of this shell from the Oolite of Hampton. The interior of the dorsal valve possesses a well defined circular ridge, entirely encircling the inner portion of the shell. In this species I have been unable to observe any trace of a central septum, which in those previously figured is well defined. The examples that occur in the Coral Rag, at Lyneham, are of the same species, and are equally rare.

ZELLANIA OOLITICA. Moore. Pl. xiii., figs. 18-20.

Shell small, triangular, rather longer than wide; front rounded; valves tapering to the beak, smooth, distinctly puntuate, thickest at the umbo; sides thick, flattened; hinge-line very short; foramen rounded.

This species is found with the *Z. Davidsoni* and *Z. Laboucherei*. It is a thicker and more triangular shell than the former, and is devoid of the striæ noticed on that shell. In its triangular and less symmetrical form it is to be distinguished from *Z. Laboucherei*; and it also wants the concentric lines on the valves characteristic of that species. The shell structure of the genus is shown by the *Z. oolitica* to be distinctly punctuate.

* In all the examples that have come under my notice, the crural processes, which are usually joined in this genus, are disconnected.

Under the microscope the shell shows a number of widely-separated, circular punctuations, which are arranged in longitudinal lines.

LEPTÆNA DAVIDSONII. Eug. Deslongchamps. Pl. xiii., figs. 21, 22.

The figures representing the above species are taken from specimens for which I am indebted to M. Eugene Deslongchamps, of Caen. They were found in the Upper Lias of May, associated with several of the species found in this country. It appears to be abundant in France, and to attain larger dimensions than any other liassic Leptæna.

I have found a single dorsal valve of this species in the Upper Lias of Ilminster, which though not in good condition, sufficiently identifies the *Leptæna Davidsonii* as a British species.

EXALANATION OF PLATE XIII.

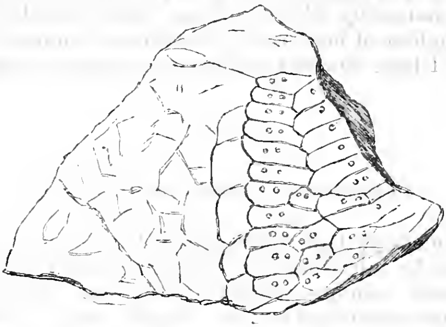
Fig. 1. *Terebratella Buckmanii*, Woodward. Interior, showing the perfect loop.
2. ——— ———. Interior of shell much enlarged, showing the loop in its first stage.
3. ——— ———. Second stage of the loop, with a rudimentary reflected portion.
4. ——— ———. Third stage, with the reflected portion of the loop now enveloped.
5. ——— ———. Perfect shell, enlarged.
6. *Terebratula maxillata*, Sowerby. Young shell, enlarged.
7. ——— ———. Interior, exhibiting the loop.
8. *Terebratella furcata*, Sow. and Moore. Enlarged exterior.
9. ——— ———. Showing perfect loop.
10. ——— ———. Profile of ditto.
11. *Terebratulina radiata*, Moore. Perfect shell.
12. ——— ———. Extorior of ventral valve.
13. ——— ———. Interior, with loop.
14. ——— ———. Elongated variety, from Dudley.
15. *Zellania globata*, Moore. Much enlarged.
16. ——— ———. Side view of ditto.
17. ——— ———. Interior of dorsal valve.
18. *Zellania oolitica*, Moore. Perfect shell, much enlarged, showing punctuated structure.
19. ——— ———. Exterior of ventral valve.
20. ——— ———. Profile of shell.
21. *Leptæna Davidsoni*. Exterior, natural size.
22. ——— ———. Ventral valve, ditto.

[The longitudinal lines indicate the sizes of the specimens, all of which are enlarged.]

(To be continued.)

ON A NEW GENUS OF ECHINODERM, AND OBSERVATIONS ON THE GENUS PALÆCHINUS.

By Fort-Major Thomas Austin, F.G.S.



Genus, Protoechinus (Austin).
Species, *Protoechinus anceps* (Austin). Natural size.

Test.—Shape not well defined in the specimens obtained. Ambulacral areas wide; the two rows of pores in double pairs near the margin, with alternate additional perforated plates near the widest spread of the ambulacra; where these additional plates intervene the pores become quadruple; interambulacral areas wide.

Differences and Affinities.—The Protoechinus differs wholly from Palæchinus; and bears but little affinity to any recent or fossil echinoderm with which I am acquainted.

Locality and Stratigraphical Range.—The only three specimens yet discovered were found in the lower beds, but not the very lowest, of the Carboniferous Limestone, at Hook Point, county of Wexford.

Some years since, when visiting the Hook district, in company with my son, Mr. T. Austin, this new and beautiful sea-urchin was discovered; but unfortunately, in my son's eager endeavours to extricate the fossil from the matrix, part of it was destroyed. Enough, however, remains to prove that it is generically distinct from Palæchinus. I obtained a second specimen, but the plates are a good deal displaced, and the ambulacra are not so well seen as in the one figured. Another and more perfect specimen was subsequently obtained; but before I could secure it, it unfortunately fell into unscientific hands, and was lost to science.

Although present during the removal of hundreds of tons of limestone, and diligently and repeatedly searching every bed and cranny in the locality, I was unable to detect the least indication of a fourth specimen. It may therefore be inferred that Protoechinus is of rare occurrence; and that when the Hook limestone was accumulating at the bottom of the Carboniferous sea, it had just appeared on the stage of life among the then living echinoderms.

As far as can be judged from the three specimens procured, I consider it to be a true echinus, and in all probability the primitive form of that now extensively diffused genus. Believing that Protoechinus was one of the first, if not the very first true echinus, that appeared on our globe, I have adopted the name as suggestive of that fact.

Observations on the Genus Palæchinus.

From specimens of Palæchinus which I have in my cabinet, there is great reason to infer that the different species belonging to that genus possessed columns similar to the true crinoids, and were attached to the ocean-bed as the crinoids were. I had long considered this as probable: and, on carefully re-examining my specimens, I found one in which the indications of the fact are so apparent that they almost force conviction that my first surmises were correct. In the specimen alluded to the ambulacra are seen terminating at, and against, a circular plate with radiating striæ on its surface, and close along side is a short portion of a column, each of the radii on which is a *fac simile* of those on the body-plate, from which the column has apparently been separated, and but slightly displaced by the pressure that broke assunder the columnar support, and left it in close proximity to its original place of attachment

I was first led to entertain a doubt about Palæchinus being a free echinoderm from finding portions of columns lying close to specimens of that genus, and which I could not refer to any known crinoid. The striæ on the articulating surfaces of the circular columnar joints, which probably belong to Palæchinus, are more deeply grooved near their margin than in Actinocrinus, or other allied forms.

Another circumstance that rather favours the supposition that Palæchinus possessed a column is the fact that it is occasionally found lying on its side, a position the true crinoids are mostly seen in; and as the lower or under side has a larger and more depressed surface than the rotund, or highly convex, lateral ones, it is a natural inference that some restraining influence produced this almost universal identity of position, and what more probable than that a column was the cause of this uniformity? Of course the presence of a column would prevent the Palæchinus, after death, falling in any other way than on its side. Among the numerous specimens which I have examined, I have never met more than two that differed in

this respect in the slightest degree, and the same exceptional cases as rarely occur among the true crinoids.

If we examine the echinoderms from the Oolite, the Chalk, or the Tertiary beds, we find them one and all reclining on their broadest diameters, in fact, obeying the laws of gravitation, but which appears to have been overcome in Palæchinus by some countervailing influence, which resisting force was probably an elongated column.

It must be understood that I do not positively maintain that Palæchinus was attached to the sea-bed by a jointed flexible column, but that one evidence in favour of such an addition to its character is strong, if not convincing.

GEMS OF PRIVATE COLLECTIONS.

UNIO AND PALUDINÆ.

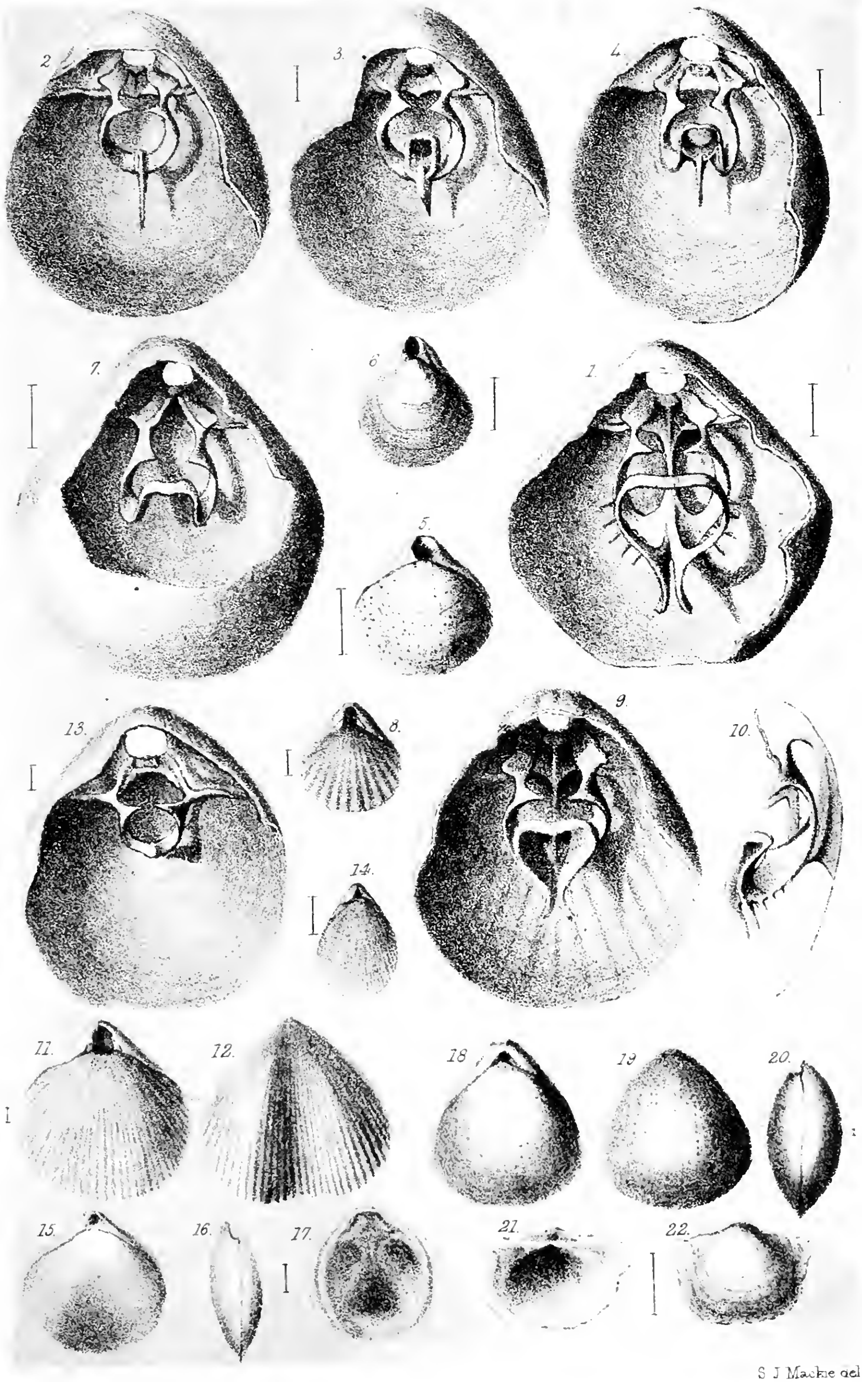
From the Wealden Beds of Kent, in the collection of
MR. W. HARRIS, F.G.S., OF CHARING.

THE Sussex Marble, or Bethersden Marble, as it is indifferently termed according to its occurrence in Kent or Sussex, is found also in Surrey, near the foot of Leith Hill. It occurs in thin courses of variable thickness and extent, but seldom presenting a bed one foot thick, in the weald clay.

It is made up chiefly of the shells of *Paludinæ*, whole or in fragments. Occasionally the shells retain their form, as in the specimen figured, and weather out on exposure; but often only their casts are exposed, the matrix being calcareous matter derived from the disintegration of the shells. The shells of Uniones also occur; rarely, as in the specimen figured, retaining this form; more often as casts. Cypridæ also occur in abundance; but the small size of the tiny shells or valves of these little entomostraca cause them to be overlooked. The *Cypridea Valdensis* is the common species. The animal matter of the Paludinæ appears to be often preserved in this marble, and gives to the polished sections the dark grey and black markings so characteristic of the stone. Purbeck marble is a similar stone, older than that of the weald clay, and formed of a Paludina of smaller size.

The Paludina of the Sussex marble is scarcely to be distinguished from that of the existing rivers and ponds, namely, the *P. vivipara*; but Sowerby points out that it has a thicker shell, and is somewhat turbo-like in aspect; and has termed it *P. fluviorum*, (Min. Conch., pl. 31. fig. 1; vol. i, p. 77, and vol. vi. p. 192). A larger form from

Pl XIII



S J Mackie del

the weald clay of Sussex is named *P. Sussexiensis* by Sowerby, in the Geol. Transact., 2 ser., vol. iv., p. 178, pl. 22, fig. 6.

Other Paludina, but of smaller size, are found in the wealden beds, namely, *P. carinifera*, (Sow. Min. Conch., pl. 509, fig. 3; and Geol. Trans., 2 ser., vol. iv., p. 178); and *P. elongata*, (Sow. Min. Conch., pl. 509, fig. 2.) Fig. 1, of the same plate, shows a similar Paludina for East Peckham.

The Uniones of the Sussex marble appear to be *Unio compressus*, (Sow. Min. Conch., pl. 594., fig. I, and *U. antiquus*, Sow. Min. Conch. pl. 594, figs. 3, 4, 5. The specimen figured in our plate (pl. xiv.), is probably the latter.

The other Wealden Unios are *Unio aduncus*, (Sow. M. C., pl. 595, fig. 2); *U. cordiformis*, (Sow., M. C., pl. 595, fig. 1); *U. porrectus*, (Sow., M. C., pl. 594, fig. 1); *U. Valdensis*, (Sow., M. C., pl. 646); *U. Mantellii*, (Sow., Geol. Trans., 2 ser., vol. iv., pl. 21, fig. 14); *U. subtruncatus*, (Sow., *ibid.* fig. 15); *U. Gaulterii*, (Sow., *ibid.*, fig. 16; and *U. Martini*, (Sow., *ibid.*, fig. 17.) Several of these are from the sandy beds far below the weald clay, that is, in the Hastings sands and their associated beds.

The Bethersden Marble used to be very extensively for building, and for making long narrow causeways along the wet and muddy roads of the wealds of Kent, Sussex, and Surry; but in both respects it is now less used. There is an account of this stone and its localities by Dr. Griff Hartley, entitled, "On Fossil shells in Kent," to be found in Mr. Lowthorp's Abridgment of the Philosophical Transactions, 4th Edit., vol., vi, p. 426. This old-fashioned philosopher refers to the Paludina bed in the blue clay "at Hinton, five miles from Maidstone, in Kent;" and at "Pluckley, in the wild of Kent."

At the former place, Unios, (or, as they are termed, "bivalvular stones,") appear to be rather numerous (as they were, indeed, near Pluckley and Bethersden); but the "turbinated," or "wreathed conchites," formed the majority. We may remark that Dr. G. Hartley, according to the mode of the day, found good reasons "for their never having been the spoils of animals;" but stones ("lapides sui generis"), formed, perhaps, of "the salts of plants or animal bodies, washed down with rain, and lodged under ground," and "disposed into such little figures!"

T. R. J.

RESEARCHES ON PSEUDOMORPHS.

By M. DELESSE. Translated from the "Annales des Mines" by H. C. SALMON, F.G.S.

TABLE I.—ENVELOPMENT *(Continued from page 399).*

Enveloping Mineral.	Enveloped Minerals. Simple Bodies &c.	Sulphides, Arsenides.	Fluorides, Chlorides.	Oxides.	Silicates.	Tungstates, Sulphates, Phosphates.	Carbonates.	Organic Substances.
Silicates.								
Edelforsite ...					Idocrase			
Augite	Graphite	Pyrrhotine		Magnetite	Hornblende, (grammatite, actinote, asbestus), olivine, garnet, œrstedite, nepheline, labradorite, mica, sphene, calamine			
Spodumene ...					Mica			
Hornblende ...		Galena, blende, pyrite, towanite		Magnetite, quartz	Augite, (diallage, smaragdite, hypersthene), hornblende (actinote), garnet, scapolite, mica, ilvaite, kyanite sphene mosandrite, talc, tourmaline, chlorite, chabasite	Apatite	Calcite	
Emerald			Fluor	Quartz	Mica, topaz, tourmaline, chlorite	Tantalite		
Olivine					Augite (bronzite)			
Willemite				Franklinite				
Humite		Molybdenite		Spinelle				
Phenakite					Mica			
Garnet		Pyrite, towanite	Fluor	Magnetite, hematite, rutile, quartz	Augite, wollastonite, hornblende, scapolite, garnet, idocrase, epidote, mica, felspar, kyanite, chlorite	Gypsum	Calcite	
Helvin		Blende			Chlorite			
Zircon					Mica			
Idocrase				Magnetite, quartz	Augite, hornblende, garnet, idocrase, epidote, mica, orthoclase, chlorite		Calcite	
Scapolite		Pyrrhotine, pyrite		Magnetite, hematite, quartz	Augite, hornblende, zircon, epidote, felspar, mica, sphene	Apatite	Calcite	
Melilite				Spinelle	Augite	Apatite		
Epidote				Magnetite	Hornblende, zircon, epidote, scapolite, felspar, mica		Calcite	
Axinite				Quartz	Actinote, orthoclase, chlorite, prehnite			
Cordierite		Pyrrhotine, pyrite, towanite			Garnet, iolite, mica			

Mica		Pyrite		Spinelle, magnetite, quartz	Augite, hornblende, asbestus, garnet, epidote, iolite, mica, felspar, andalusite, topaz, staurolite, kyanite, tourmaline	Apatite		
Sodalite.........					Augite, hornblende, garnet, haüyne, mica			
Lazulite.........		Pyrite						
Haüyne					Augite, mica			
Leucite					Augite, olivine, garnet, biotite, haüyne, leucite, sanidine, lava			
Nepheline......				Magnetite	Augite, garnet, melilite, mica, haüyne, cancrinite	Apatite		
Felspar (albite oligoclase labradorite, anorthite)	Gold		Fluocerine	Magnetite, corundum, hematite, ilmenite, rutile, quartz	Augite, hornblende, amianthus, olivine, garnet, zircon, scapolite, epidote, mica, orthoclase (mikrolite), sphene, chlorite, mesotype	Tantalite, apatite		
Felspar (orthoclase)	Graphite	Galena, pyrite, molybdenite, mispickel		Magnetite, corundum, hematite, rutile, anatase, chrysoberyl, quartz	Augite, hornblende (actinote) garnet, zircon, allanite, epidote, axinite, mica, nepheline, albite, oligoclase, sphene, andalusite, tourmaline, chlorite, wöhlerite	Tantalite, niobite, samarskite, apatite	Calcite	
Andalusite ...					Mica, andalusite, kyanite, clay-slate			
Topaz............				Hematite, ilmenite, cassiterite, rutile. quartz	Topaz, mica (lepidolite), tourmaline	Wolfram		Brewstoline, cryptoline, bituminous matters,
Staurolite				Quartz	Mica, kyanite			
Ilvaite		Galena, blende, pyrite, towanite						
Kyanite.........	Graphite			Corundum, hematite, rutile, chrysoberyl	Garnet, mica, andalusite, staurolite, kyanite			
Sphene (grenovite)				Braunite	Sphene, chlorite			
Tourmaline ...		Miargyrite		Quartz	Hornblende (actinote) garnet, mica, (lepidolite) orthoclase, tourmaline, talc, chlorite	Apatite, uranite		
Talc				Magnetite, spinelle	Hornblende, garnet, tourmaline, chlorite	Apatite	Dolomite, chalabite	
Meerschaum ..				Flint	Olivine			

TABLE I.—ENVELOPMENT (*Continued*).

ENVELOPED MINERALS.

ENVELOPING MINERAL.	Simple Bodies &c.	Sulphides, Arsenides.	Fluorides, Chlorides.	Oxides.	Silicates.	Tungstates, Sulphates, Phosphates.	Carbonates.	Organic Substances.
Silicates.								
Serpentine ...	Platinum, copper	Pyrrhotine, mispickel		Magnetite, chromite, ilmenite, brucite, nemalite, quartz (opal, chrysoprase)	Diallage, olivine, garnet (pyrope), felspar (saussurite, labradorite, oligoclase), biotite, serpentine, chrysotil, bastite, chlorite		Calcite, magnesite, hydromagnesite	
Chlorite.........		Galena, pyrite, mispickel		Magnetite, corundum	Hornblende, topaz, garnet, sphene, tourmaline		Calcite, dolomite	
Chloritoide ... (sismondine)				Diaspore				
Bastite					Serpentine			
Apophyllite ...	Copper, bornite	Pyrrhotine, pyrite, marcasite, mispickel			Mesotype			
Laumonite ...				Anatase				
Calamine		Galena					Smithsonite	
Prehnite					Hornblende (amianthus)			
Analcime	Copper			Hematite	Augite, apophyllite			
Chabasite		Towanite			Augite, hornblende, chlorite, analcime, chabasite		Calcite	
Harmotome...		Galena, pyrite, towanite		Hematite				
Phillipsite......				Magnetite				
Mesotype ...... (speustein)					Scapolite (eleolite), felspar (oligoclase)			
Stilbite		Pyrite, mispickel		Hematite	Quartz, amianthus, green earth		Calcite	
Datholite				Magnetite, hematite				
Aspasiolite ...					Iolite			
Thomsonite ... (comptonite)					Augite, analcime			
Argile............		Pyrite		Hematite, limonite	Pimelite	Gypsum, alum, websterite, erythrine	Calcite, dolomite chalybite, malachite	Organic substances, vegetables, animals
Mosandrite ...					Mica			
Titanates, Tungstates Molybdates Chromates.								
Pyrochlore ...				Iserine				
Scheelite				Cassiterite, quartz				
Tantalite					Emerald, iolite	Uranite		
Wolfram						Wolfram		
Œschynite ...					Zircon, orthoclase			

Sulphates.								
Baryte	Gold, mercury silver, copper, bismuth	Realgar, bismuthine, antimonite, argentite, galena, blende, redruthite, cinnabar, pyrite, cobaltine, smaltine, copper-nickel, marcasite, towanite, bournonite		Hematite, manganite, pyrolusite, limonite, quartz, sand		Baryte, erythrine	Dolomite	
Celestine	Sulphur	Pyrite						
Anhydrite......				Quartz		Boracite		
Anglesite		Galena		Limonite				
Polyhalite......			Rock-salt					
Gypsum	Sulphur	Realgar, antimonite, galena, pyrite	Rock-salt	Quartz, flint	Garnet, mica, talc, argile	Anhydrite, gypsum, boracite	Aragonite, dolomite, magnesite, malachite	Oxalite, lignite, vegetables, animals
Alunite	Sulphur							
Boracite		Pyrite	Rock-salt	Quartz				
Phosphates.								
Apatite		Marcasite, towanite		Magnetite, hematite, cassiterite	Zircon, mica, tourmaline, talc, chlorite, argile	Wolfram, cryptolite	Calcite	
Pyromorphite				Limonite, quartz		Baryte		
Annabergite...		Copper-nickel						
Carbonates.								
Calcite	Silver, copper, bornite, sulphur, graphite	Realgar, antimonite, antimonsilber, argentite galena blende redruthite, pyrrhotine, breithauptite, millerite, pyrite, marcasite, mispickel, molybdenite, towanite, heteromorphite, pyrargyrite, fahlerz	Bromite, fluor	Spinelle, magnetite, franklinite, emery, hematite, limonite, quartz, sand	Batrachite, augite, wollastonite, hornblende (grammatite, strahlstein), amianthus, humite, garnet, idocrase, epidote, scapolite couzeranite, meionite, mica sodalite, haüyne, lazulite, felspar, albite, gehlenite, tourmaline, green-earth, chlorite, apophyllite, stilbite, mesotype	Baryte, celestine. apatite	Calcite, chalybite malachite, azurite	Bitumen, anthracite, combustibles, vegetables, animals
Magnesite......					Talc			
Dolomite	Mercury	Realgar, argentite, redruthite, blende, cinnabar, pyrite, towanite, marcasite, dufrénoysite		Magnetite; corundum, hematite, quartz	Augite, hornblende (grammatite, asbestus), garnet, mica, albite, tourmaline, talc, chlorite	Erythrine		Vegetables, animals
Chalybite	Bismuth	Bismuthine, galena, millerite, pyrite, marcasite, towanite		Rutile, quartz			Chalybite	Vegetables, animals
Diallogite		Galena, blende, pyrite			Garnet			
Witherite		Blende						
Cerussite		Galena	Bromite	Limonite				
Baryto-calcite				Limonite				
Malachite		Bournonite		Cuprite			Azurite	
Organic Substances.								
Amber							Calcite	Vegetables, animals
Bitumen				Quartz, chalcedony			Calcite	
Idrialine		Cinnabar						
Lignite, coal, anthracite		Pyrite		Limonite	Argile	Gypsum	Calcite, chalybite lithoid	Amcer, mellite, vegetables, animals

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—June 13, 1860. *(Continued.)*

2. "On some Arrow-heads and other Instruments found with Horns of *Cervus megaceros*, in a Cavern in Languedoc." By M. E. Lartet, For. M.G.S. (In a letter to the President.)

In a cavern of the limestone at Massat, near Tarascon in Languedoc (Department of Ariege), examined by M. A. Fontan, the floor was found to consist of a blackish earth, with large rounded pebbles, among which were mixed, in great disorder, bones and Horns of a Chamois, *Cervus pseudovirginianus*, *C. megaceros*, and *Bos*, together with implements of stone and bone, to which MM. Isidore Geoffroy Saint-Hilaire and E. Lartet have referred to in the 'Comptes Rendus' of May 10, 1858.

M. E. Lartet in his letter, has furnished drawings and descriptions of some barbed arrow-heads of bone, some having indented grooves, probably for the appliance of poison; also needles, and a flute-bevelled tool of bone, a splinter or knife of hard flint, and the horn of an Antelope hacked at the base, probably when the animal was flayed.

3. "On the occurrence of Crag Shells beneath the Boulder-clay in Aberdeenshire." By T. F. Jamieson, Esq. Communicated by Sir R. I. Murchison, V.P.G.S.

In a former paper (Q. J. G. S. vol. xiv., pp. 522-525) the author referred to the existence of gravelly beds containing marine shells underlying the boulder-clay between Couden and Slains, on the coast of Aberdeenshire, over an area of about six miles by three and a half; these shelly sands and gravels he has since more carefully examined, and he refers them to the age of either the Red or the Mammaliferous Crag of England. *Cyprina rustica*, *C. Islandica*, *Astarte*, spp., *Venus*, spp., *Artemis lincta*, *Cardium* spp., *Pecten opercularis*, var. *Audouini*, *P. maximus?*, *P. princeps?*, *Pectunculus glycimeris*, *Tellina solidula*, *Mya truncata?*, *Fusus antiquus* and its variety *contrarius*, *Mangelia*, *Purpura lapillus*, var. *crispata*, occur in worn fragments. *Cyprina Islandica* is the most abundant.

Chalk-flints are common among the materials of the beds in question; also fragments of fossiliferous limestone and of red and grey sandstones, of undetermined age.

4. "On some small fossil Vertebræ near Frome, Somersetshire." By Prof. Owen, F.R.S., F.G.S.

In this communication Prof. Owen described three minute Vertebræ discovered by Charles Moore, Esq., F.G.S., in an agglomerate occupying a fissure of the Carboniferous Limestone, near Frome in Somersetshire, in company with teeth of a small Mammal allied to the *Microlestes* of Plieninger. The vertebræ are stated to correspond in size with the teeth of *Microlestes*; but to have Reptilian characters, especially in their biconcave structure,—a character common in Mesozoic Saurians, but rare in the existing genera. There appears to be but very slight grounds for supposing that such a character may have ever belonged to any Mammals, although some of the existing *Monotremata* have peculiar vertebral modifications somewhat resembling, in these respects, the structural features of Reptiles. In their large and anchylosed neural arch, however, these little vertebræ present a mammalian character.

Remains also of small Saurians and Fishes occur in considerable numbers with the vertebræ in question, as well as the more rare mammalian teeth.

November 7, 1860.

1. "On the Denudation of Soft Strata." By the Rev. O Fisher, M.A., F.G.S.

The author first described the general features of the north-eastern portion of Essex, with the table-lands of gravel, clay valleys, and tidal rivers. The present configuration of the district cannot be due, in the author's opinion, to the action of such causes as we see now in operation on the coast, combined with a slow elevation of the land. As a rule, the sea waves cannot excavate long narrow islets in horizontal and homogeneous beds, such as the gravel and clay of the district under notice, but give rise to long, approximately straight lines of cliff. The rounded sides of the Essex valleys seem to show they were not formed by wave-action; nor are there any evidence of shingle-beds at the foot of the hills. Mr. Fisher believes that the surface of this district, and that of many other districts composed of yielding strata, must have been formed by a superincumbent mass of water drained off from a flat or slightly dome-shaped area. Slight depressions, cracks, or lines of readily yielding materials would determine the drainage-streams as the water retreated; and these channels would be more or less scoured out according to the velocity of the water. Where the gravel covering of such a district was cut through, the clay beneath would be channelled with a narrower valley; and where the gravel was wholly removed, the valleys would be wider and the intermediate high ground rounded instead of being flat topped, just as is represented in those parts of the district where the clay composes the surface.* Similar appearances may be seen on a small scale in the mud of a tidal river. Tidal action, however, is not, according to the author, calculated to excavate narrow valleys in horizontal beds.

Mr. Fisher suggests that the land must have been elevated by a sudden movement sufficient to have caused a rush of water from the raised portions to seek a lower level,—either the land being raised high and dry at once, or the sea-bottom raised to a higher level, though still remaining beneath water. Such an elevation might be repeated again and again, with intervals of submergence; and such conditions appear to have obtained in Norfolk as well as in Essex.

The author states that, in his opinion, escarpments, such as are so common among the secondary and tertiary beds, are rarely old cliffs, and their often rounded forms must be due to agencies similar to those which have produced the valleys of Essex. In some deep gorges of the Chalk near Dorchester the author has seen flints and great blocks of Tertiary puddingstone so arranged as to leave little doubt of their having been left by violent currents of water The position of the Marlborough "Weathers" is also attributed by the author to torrential action.

Brick-earth is in part referred by Mr. Fisher to the deposition of sediment from turbid waters; but also in great part to the unlading of icebergs.

With regard to the manner in which the uprising of the land, which brought about these aqueous cataclysms, has been effected—whether by one slow and continued movement, or by one or more sudden movements, or by a mixed succession of these, the author argued that a slow and gradual elevation is not in accordance with the contour of the existing surface of our softer strata; that the elevation of the land previous to the period of the great-mammalian fauna, when its present contour was mainly given, was not gradual; and that, after subsequent depressions, there have been sudden depressions since that period.

Lastly, it was pointed out that sudden vertical movements of the surface on a grand scale are of as probable occurrence as those lesser movements with which we are historically acquainted, because, both in the case of strata pre-

* Compare with Mr. Frere's remarks in the "Archæologia:" 1797. Ed, Geol.

viously unbroken and in that of strata once faulted but at rest, the pressure requisite to rupture or to fold them will accumulate enormously before they yield to it, when, after some slow and gradual movements, they will be thrown up or down with a sudden movement, with or without flexures, as the case may be. Thus, by mechanical considerations, the author is led to believe that the ordinary nature of movements of the earth's crust must be sudden.

2. "On an undescribed Fossil Fern from the Lower Coal-measures of Nova Scotia." By Dr. J. W. Dawson, F.G.S.

In a paper on the Lower Carboniferous rocks of British America, published in the 15th volume of the Geological Society's Journal. Dr. Dawson noticed some fragmentary plant-remains which he referred with some doubt, the one to *Schizopteris* (Brongn.), and the other to *Sphæreda* (L. and H.) With these were fragments of a fern resembling *Sphenopteris* (*Clyclopteris*) *adiantoides* of Lindley and Hutton. Since 1858 the author has received a large series of better-preserved specimens from Mr. C. F. Hartt; and from these he finds that what he doubtfully termed the frond of *Schizopteris* is a flattened stipe, and that the leaflets which he referred to *Sphenopteris adiantoides* really belonged to the same plant. Mr. Hartt's specimens also show that what Dr. Dawson thought to be *Sphæredæ* were attached to the subdivisions of these stipes, and are the remains of fertile pinnæ, borne on the lower part of the stipe, as in some modern ferns. This structure is something like what obtains in the Cuban *Aneimia adiantifolia*, as pointed out to the author by Prof. Eaton, of Yale College. No sporangia are seen in the fossil specimens.

Dr Dawson offers some remarks on the difficulties of arranging this fern among the fossil *Cyclopterides*, *Næggerathiæ*, and *Adiantites*; and, placing it in the genus *Cyclopteris*, he suggests that it be recognized as a subgenus (*Aneimites*) with the specific name *Acadica*.

The regularly striated and gracefully branching stipes, terminated by groups of pinnules on slender petioles, must have given to this fern a very elegant appearance. It attained a great size. One stipe is twenty-two inches in diameter, where it expands to unite with the stem; and it attains a length of twenty-one inches before it branches. The frond must have been at least three feet broad. The specimens are extremely numerous at Horton.

The author then notices that the long slender leaves so common in the Coal-measures of Nova Scotia, and hitherto called *Poacites*, though sometimes like the stipes of *Aneimites*, are probably leaves of *Cordaites*.

On some specimens of *Aneimites Acadica* markings like those made by insects have been observed; also a specimen of the *Spirorbis carbonarius*.

3. "On the Sections of Strata exposed in the excavations for the South High-level Sewer at Dulwich; with Notices of the Fossils found there and at Peckham." By Charles Rickman, Esq. (Communicated by the Assistant-Secretary.)

In the autumn of 1859, open cuttings were made at Peckham, in connexion with the "Effra branch of the Great South High-level Sewer," for the "main drainage" of the metropolis south of the Thames; and in the following spring a tunnel (330 yards in length) was being constructed under the Five-fields at Dulwich. The beds exposed in both sections belonged to the "Woolwich and Reading Series" of the London Tertiaries (Prestwich).

Four shafts were sunk to facilitate the driving of the tunnel; and the followng beds were exposed; but as some of the beds are not persistent, but die out even with the extent of the tunnel, the several shafts differed as to the sections obtained from them.

1. Soil, nine inches. 2. Loamy Clay (probably London Clay); twelve feet. Not in shaft No. 1 (the most easterly), nor in No. 4 (the most westerly), owing

to the convex surface of the ground. 3. Light-coloured Clay; six to nine feet. 4. Reddish sand; five feet. Not in No. 4 shaft. 5. Dark clay; one foot, ten inches. 6. Blue clay; two feet. Not in No. 4. 7. Dark clay; one foot. In No. 1 only. 8. Paludina-bed; six to fifteen inches. Fossils: *Pitharella Rickmani* (Edwards), *Paludina lenta, P. aspera* (?). Bones and scales of Fish. Leaves. 9. Cyrena-bed; one to two feet. *Cyrena cuneiformis*, &c., 10. Oyster-bed; one to three feet. *Ostrea tenera, O. pulchra, O. Bellovacina, O. elephantopus, O. edulina, Bysso-arca Calliaudi (?) Cyrena cuneiformis, C. deperdita, C. cordata, C. obovata, Melania inquinata, Melanopsis brevis, Modiola elegans, Fusus (?). Calyptræa trochiformis, Corbula.* 11. Loamy sand; eight inches. In No. 4 only. 13. Blue clay; two feet six inches. Leaves. 14. Dark sand; eight to twenty-eight inches. 15. Blue clay: eighteen inches to nine feet. Laminated; rich in Leaves, Lignite, Seed-vessels. *Rissoa, Cyrena Dulwichensis* (Rickman), *C. cordata, C. deperdita, C. cuneiformis. Melania inquinata, Melanopsis, Neritina, Pitharella Rickmani* (Edwards), *Unio, Teredines* in Lignite, Scutes of Crocodile, Fish-scales, Chelonian and Mammalian bones. 19. Clay; fourteen feet and more. Reached only by the main shaft, No. 3, which appears to have been sunk at the apex of a low anticlinal; the beds gently dipping away east and west.

All the fossils appear in their respective beds both at Peckham and Dulwich.

Glasgow Geological Society.—It is a great pleasure to us to acknowledge the first printed paper of this society, a paper on the geology of the Campsie district, by Mr. John Young, one of the Vice-Presidents; and an excellent paper it is. The locality is lucidly described; sections and borings properly recorded; and a very careful list of the Carboniferous fossils appended. Mr. Davidson in his admirable monograph of the Scottish Carboniferous Brachiopoda, published in this journal, has acknowledged the great assistance and stores of material he had received from the Glasgow geologists; and they are well-deserving of praise for the persevering and proper manner in which they have set to work at the geology of their own territory. During the past year they have had lectures and papers on the hypothesis of "Creation by Law:" by their President, J. P. Fraser, Esq., F.G.S. "On Volcanic Phenomena:" by Professor H. D. Rogers. Four lectures for beginners: by Thomas Struthers, Esq., Vice-President. "On British Mining:" by Mark Fryar, Esq., of the School of Mines, Glasgow. "On Certain Points of Contact between Geology and History:" by James Bryce, Esq,, L.L.D., F.G.S. "On the Succession of Extinct Organic Forms:" by William Keddie, Esq., Free Church College. "On the Relative Antiquity of Existing Species," and "On Osteology:" by John Scouler, Esq., M.D., L.L.D. "On the Structure, Affinities, and Geological Range of the Eurypterites, or Gigantic Crustaceans of the Palæozoic Era.:" by David Page, Esq., F.G.S. "On the Boulder Drift, Raised Beaches, and Parallel Roads," and "Some Account of the Latest Extinct Terrestrial Animals, and the Traces of Primeval Man:" by Professor H. D. Rogers. "On the Philosophy of Geology:" by David Page, Esq., F.G.S. "On the Natural History of the Invertebrate Animals in connection with the Extinct Species:" by William Keddie, Esq,, Free Church College.

Besides which, during the Summer Session, there have been Excursions under the able direction of the members of the Council, every alternate Saturday. The places thus visited were Dumbuck and Auchenreoch Glen; Nitshill and neighbourhood; Campsie; Strathblane and neighbourhood; High Blantyre; Craigenglen.; Corrie Burn; Coatbridge and Airdrie.

The Lectures announced for the ensuing year are:—Four Initiatory Lectures "Upon the Principles of Geology:" by Thomas Struthers, Esq., Vice-President.

"On the Useful Minerals:" by Mark Fryar, Esq., F.G.S., Glasgow School of Mines. "On the Formation of Amygdaloides:" by John Scouler, Esq., M.D., L.L.D., President. "On the Methods of Scientific Investigation, with special application to Geology:" by Rev. H. W. Crosskey. "On the Permanence of Species:" by John Scouler, Esq., M.D., L.L.D., President.

Besides these, the Council have determined on having an Exhibition of Rocks, Metals, and Fossils, during the present Session, and circulars requesting contribution have been issued. The time is fixed for the 27 and 28th of December; and the Exhibition will take place in the Merchants' Hall. The Carboniferous fossils are expected to be very numerous and excellent, as several of the members of the association have paid great attention in collecting and arranging their cabinets of specimens.

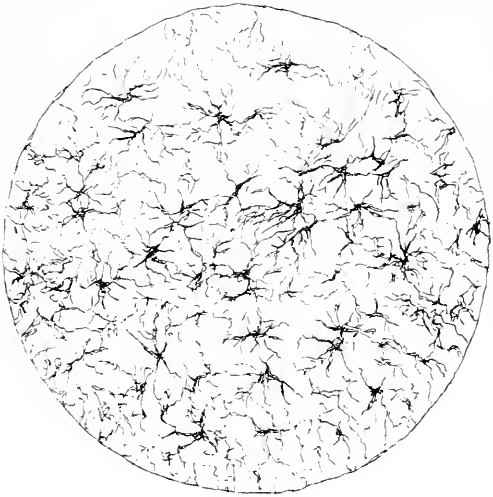
This last is a very desirable proceeding, and cannot but be productive of good results. The Society now numbers upwards of one hundred and seventy members; no small number for a *commercial* city, like Glasgow, where every hour from business is regarded as so much pecuniary loss; and, therefore, we may well believe what we hear from every quarter, that the members are all animated with the determination to work out *their* department of Scottish Geology and Palæontology.

We all know how much good work the Cotteswold, Malvern, Worcester, Newcastle, Cornwall, and other English Field-Clubs have done; but the comparison of the first number of the Glasgow Transactions, not only shows itself to be worthy of ranking in the first classof local productions, but augurs well for the future advancement of Geological Science by the Glasgow men, and we shall regard with great interest their future doings.

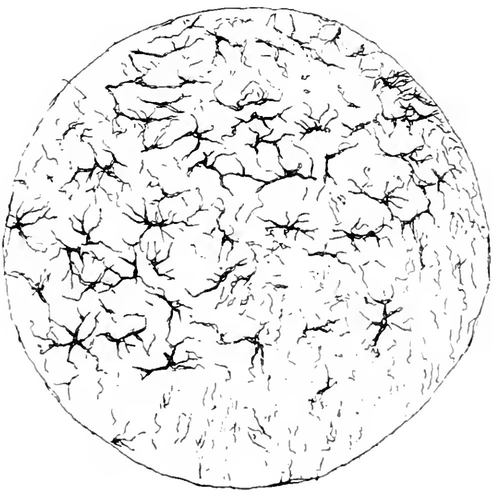
NOTES AND QUERIES.

Structure of the Scales of Lepidotus and Lepidosteus.—Few departments of palæontology are of greater interest than the microscopical examinations of organic structures; and the interest is increased where a comparison can be made between the organization of fossil specimens with that of recent beings of the same or allied genera. The accompanying figures give an example of such a comparison. It is well known that in the Wealden beds there are remains of a fresh-water fish, called the *Lepidotus*: its scales are amongst the most frequent fossils of this formation. It is also known that an allied genus, the *Lepidosteus*, or Garpike, which is one of the few heterocercal fishes (or those which have the vertebræ prolonged into the upper lobe of the tail), is now living in the rivers of America. The figures give enlarged views of very thin sections of scales from the two fishes, magnified about two hundred and fifty times, and etched direct on the copper by means of the camera lucida fitted to the eyepiece of the microscope. (See pl. xii.)

The upper figure is from the recent *Lepidosteus*, or Garpike, of the Mississippi. The lacunæ and the canaliculi ramifying from them are beautifully shown, and are very characteristic; but the chief interest of the plate arises from the comparison of the structure of the upper, or recent specimen, with that of the lower figure, which represents a section of a scale from the fossil *Lepidotus*, found in the Wealden formation of Sussex. The organization seems to be almost identical; and if the plate were reversed, and the letters erased, it would be difficult for an unpractised eye to say which was the recent and which the fossil scale.



Recent Lepidosteus or Garpike
of the Mississippi.



Lepidotus Fittoni from the
Wealden of Sussex.

When we consider the ...
the time when the World ...
is ...
made use of ...
of countless ...

Does not the fact ...
thin-stratified ...
whose time ...
went through ...

British ...

"I was ...
seen ...
and work ...

The ...

Olmsted, Hess, Pal, Simmons, etc.

When we consider the immense lapse of ages which have intervened between the time when the Wealden beds were formed, and the present age, it certainly is an object of no common interest to find almost the identical organization made use of when a similar being is called into existence, even after the lapse of countless ages.

Does not this fact point rather to some universal law, according to which certain structures were associated with certain forms, predetermined by Him, to whom time is as nothing, rather than to a law of incessant change or development through successive ages?—JOHN EDW. LEE, F.G.S.

BRITISH BRACHIOPODA.—[Extract of letter from T. Davidson, Esq.]—"I can assure you that I have never worked harder than during the present year, and I shall have got through a considerable amount of, I hope, good work. You will be glad to learn that I have been attacking the genus Productus, and have made out thirty species in the British Carboniferous strata, rejecting many old ones, however, and introducing others new to England. Among these I may name *Prod. armineus*, *P. proboscideus*, *P. sinuatus*, *P. Keyserlingiana*, *P. arcuarens*, *P. Wrightii*, and one or two more. I have spared no trouble in assembling all the best British material. I shall try to complete my Carboniferous Monograph next year: it will contain fifty or more plates; and hope to be ready soon with another part for the Palæontological Society. I have also worked out the Indian Carboniferous species, and have two or three more papers in hand for the winter."

EXCHANGES AND PURCHASES OF FOSSILS AND BOOKS.—SIR,—I think many of your subscribers will be, like myself, desirous of making exchanges of duplicate fossils, without knowing to what gentlemen to apply. I think it would be well if you could invite geologists to send in their names and places of abode, and particularly also the characteristic strata of their localities, that we might enter into correspondence with one another, so as to make such exchanges as we desire for our private collections. Example.—Cretaceous Formation.—Upper Chalk, Middle Chalk, Red Chalk.—ROBT. MORTIMER, Fimber, Malton, Yorkshire.

We shall be happy to assist in these exchanges, as we have said on many former occasions. It seems to us, however, that the best way would be to open a page in our advertising sheet at a small fee, where we would print the names of fossils offered, and those required in exchange. From numerous applications for the purchase of geological works, we think it would also be desirable to do the same with regard to books, quoting those offered for sale and those which are wanted for purchasers.—ED. GEOL.

METEORITE OF AGRAM.—Director Haidinger communicated last year to the Imperial Academy of Vienna the original document, written in Latin, concerning the fall of this iron mass, as observed by eye-witnesses and confirmed by the official testimony from the ecclesiastical authorities of Agram. Another contemporaneous document, illustrated by a drawing, gives an account of the same phenomenon, as observed at Szigethvar, fifteen Austrian miles east of Agram, by some officers and clergymen. The apparent diameter of the fiery globe, as observed at this place, was equal to that of the sun, which (if its altitude, as calculated from this and other observations, amounted to about ten German miles) answers to a real diameter of more than three thousand feet. This, if compared with the solid mass which fell to the ground (fifty-seven feet in all), indicates an enormous development of ignited gaseous substances.

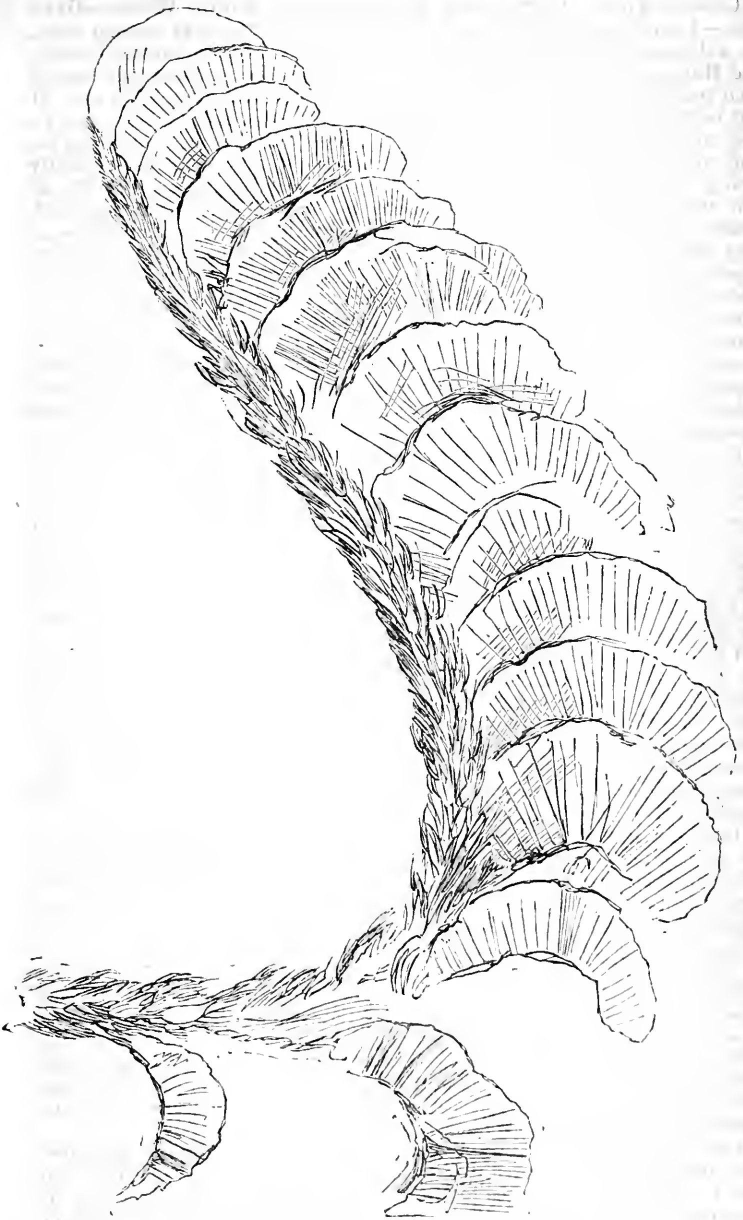
The luminous train of the bolide perished more or less distinctly from six to ten p.m. The apparent point of its departure, as made probably by the direction of its orbit, was the constellation of Perseus, from which next to Leo the majority of igneous globes are apparently proceeding, as observed by MM. Olmsted, Heiss, Tul, Schmidt, &c.

CURIOUS FOSSIL PLANT FROM COAL-MEASURES, SOUTH WALES.—DEAR SIR,—I have lately added to my collection of coal-plants a very singular fossil, for a description of which I have searched the works of Sternberg, Lindley, and Hutton in vain. I have therefore delineated it, in the hopes that some of your readers learned in the flora of the Coal-Measures will name it for me. If any body has discovered a similar specimen I shall be glad to know, that we may compare notes. The stem, as will be seen in the drawing, appears to belong to the Lycopodiaceæ, and these big leaves (if they be leaves) evidently belong to the stem, and are not lying by its side by chance, because on the inside they all merge into it, there being no marked line of junction; and, besides, they follow the peculiar bend of the branch, both decreasing in size as they approach the terminal point, which in fact is formed by a leaf. Yet there appears to be no connecting branch to the leaves, unless we except the one which appears to be torn off near the beginning; but as the specimen is somewhat confused at this point, we cannot instance this particular leaf as an example of how the others are joined to the stem. In fact, at the attached margin they appear to be sessile as regards the branch, having the opposite margin free or unattached. As regards each other, they are apparently closely imbricated, each leaf somewhat reniform in shape, and marked distinctly with a number of short parallel veins coming directly from the upper margin, but with a slight tendency to meet at the base. Whether they are continued in this manner behind each leaf, I cannot say; but, judging from the two or three first detached leaves, which appear to have a well marked lower as well as upper margin, I should imagine not. The great puzzle to me is the likeness of the stem to the Lycopodiaceæ; but, if it is so, either the little leaves which embrace the stem and fall off, leaving badly defined scars, are not leaves, or else these other portions are not leaves. And, if they are not leaves, can it be a species of inflorescence; because, according to Lindley, the Lycopodiaceæ are flowerless.

I shall be very grateful if you or any body else would solve the difficulty for me. And while on the subject, I wish some one of our fossil-botanists would begin a new edition of Lindley and Hutton, the last being thirty years old. Since those plates, as well as those of Sternberg, were published, there have been many new species found, which sadly want naming, figuring, and describing. I have in my own cabinet several which, for want of better information, I have been obliged to name provisionally.—I am, dear Sir, yours faithfully, G. P. BEVAN. Beaufort, Mon.

TERTIARY PLANTS OF AUSTRIA.—Prof. Unger has prepared the materials for the description of some Tertiary plants, to be published under the title of "Sylloge Plantarum Fossilium," as a continuation of his "Iconographia Plantarum Fossilium, published some years ago in the Transactions of the Vienna Academy, and with special reference to the species enumerated in his "Genera et Species Plantarum Fossilium." Besides other collections, the immense stores of the Imperial Geological Institute of Vienna have furnished valuable materials. The first number of the "Sylloge" is illustrated with twenty colour-printed plates, and describes plants of the families *Characeæ, Salviniaceæ, Equisetaceæ, Musaceæ, Coniferæ, Santalaceæ, Myssaceæ, Proteaceæ, Oleaceæ, Fraxineæ, Sapotaceæ, Ampelideæ, Annonaceæ, Magnoliaceæ, Malpighiaceæ, Sapindaceæ, Juglandeæ, Anacardieæ,* and *Burseriaceæ*; most of them with their fructification, and generally with particular reference to the neuration of their leaves, compared with those of analogous recent forms.

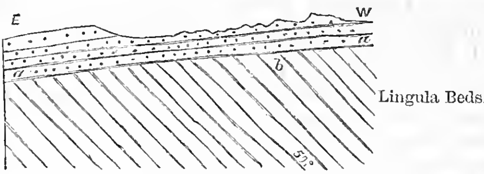
PTERASPIS AND COCOSTEUS.—We have lately found the Pteraspis near Newport, and I have also secured two or three fine fossils from the Old Red. At first I thought they belonged to Pteraspis; but I now suspect that they are the dorsal plates of Coccosteus rather pressed together. They are rather larger.



Fossil Plant from Coal-Measures, South Wales.

Both these are new in the red sand of the neighbourhood.—[Extract of letter from J. E. Lee, Esq., Caerlton, Monmouthshire.]

Extract of a Letter from a Ludlow Geologist.—Dear Sir,—I amuse myself over the fire this evening by writing (with a miserable pen) the results of our day's walk. M——. and I went from here this morning to Pedwardine. and had the good fortune to find plenty of the *Dictyonema sociale*. The Lingula beds are well shown in the bottom of the first cross lane from Brampton



a a, Llandovery Beds ; *b*, Lower Llandovery Beds.

Brian dipping at about this angle fifty degrees to the west; and the Llandovery beds cover them unconformably, with a gentle dip to the east. The first Llandovery bed is thin—two or three inches only—and of a yellow earthy character; the next is a fine conglomerate bed (coarse sand and fine gravel), about five or six inches; then a thicker earthy yellowish bed. Above this the rock is mixed up with soil and penetrated by roots, and becomes obscured. Nearly at the east extremity of the Lingula flags there is a crush, twisting the strata a little out of place; and higher up the lane are seen the massive beds of coarse Llandovery conglomerate, the same that are seen at the bottom of Brampton Brian Park.

We could find no trace of anything except Dictyonema, unless it be a small round shell, which I suppose may be a minute Lingula: it is quite smooth. Of this we found several. The Lingula beds are all thin papery beds of fine smooth silt.

We then crossed over, to try and find another place where M——. had found *Dictyonema*, in the road leading up under Wigmore Rolls to Adforton, but could not meet with any. The only beds we could see were Wenlock Shale, and in general very barren, but in some places containing fragments of trilobites, &c. My friend declares that he found the very same *Dictyonema* here, and in these same Wenlock beds; but as the genus is known in strata of that age, in America, it is possibly another species. You will be glad to know of its occurrence here in any form.

We have just got from the quarry here a fine specimen of *Palæocrinus ferox* showing the five arms; the centre is a rotten mass, yet I think it is the best specimen, altogether, I have seen. You know that the *Protaster Miltoni*, (as well as *P. vermiformis*,) is found at Trippleton roadside quarry. We have also

got from Trippleton a curious *Bryozoan* form like this, which we fancy to be something new. It is not unlike an *encrinite* with several heads on one stem.

Churchhill quarry is ruined; and, believe me, the men who find anything there are well deserving of their pay on a liberal scale, for it is almost impossible to find any starfish, unless by many hours of slavish labour, or by great good luck in breaking up all the debris, lying about the quarry—almost as hopeless as *Palæopyge* hunting. We could find nothing yesterday, in four hours, but one indifferent encrinite, and a few fragments of starfish, which, however, we preserve with care. My friend is so disgusted, that he says he shall not trouble the quarry again.—R. LIGHTBODY.

MOUNTAIN LIMESTONE FOSSILS.—SIR,—Have the Mountain Limestone fossils (mollusca) been described and figured? When? By whom? Hugh Miller (I quote from memory, not having a copy of the Old Red Sandstone by me at present) says old David Ure figured and described, after a manner, every fossil he collected, belonging to the Coal Measures; whether the Limestone fossils were described I know not. Since I have been in this locality, rather more than a year, I have collected about three hundred specimens of Limestone fossil mollusca, including, I know not, how many genera. I want now to know the names of them, so that I may arrange them according to the directions you advised a brother student some time since. I like not to become obtrusive, but I should like very much to enter into correspondence with any fellow labourer in the geological field, where an exchange of thought and a barter of fossils would serve both parties.

Allow me to express my thanks, though the utterance comes from the mouth of a working man, for the new light you have thrown on the geology of the Bottom-rocks. After I had paid five shillings for the "First Traces of Life" I assure you I demurred, "because it was so thin;" I have been, however, compensated by the "thickness" of the contents. No book that I have read during the last year has made me think more than yours. There are some chapters that I have read and re-read with additional pleasure every time I opened the book afresh.—Yours faithfully, G. R. VINE, Castlemaine-street, Athlone, Ireland.

There is no published separate list of the fossils of the Mountain Limestone. Ure figures several in his "History of Rutherglen;" Phillips, several in the "Geology of Yorkshire," 2nd vol.: a great many are figured by M'Coy, in a work on the Carboniferous fossils of Ireland; as also many are by Prof. De Koninck, in his "Animaux Fossiles du Terrain Carbonifère de la Belgique." Others are to be met with in different works on various localities.

CRYOLITE IN MANUFACTURES.—Sir,—Can you be good enough to give me any account of the history of the introduction of Cryolite for use in the manufactures? It is just now most interesting in relation to aluminium. I think I have seen somewhere that it was used on the Continent first in the manufacture of Soap.—J.C.S.

There was a paper on Cryolite in the Geological Society's Journal, about four years since, by Mr. Taylor, communicated to that society by Professor Tennant. There was also a paper read before the Society of Arts, on "Aluminium," by Mr. Forster, the Secretary, about three years since. Some of our readers may be able to give a more definite reply to this query.

ALABASTER AND LIGNITE IN TERTIARY ROCKS OF TUSCANY.—Pure alabaster appears to be peculiar to Western Tuscany. It occurs in ovoidal masses, often three feet in diameter, in selenitic marls of Miocene age in the Val di Marmolajo. Coloured alabaster is also found in some of the Pliocene beds of Tuscany. Gypsum is widely distributed waere serpentine has pierced limestones, as at Matarana and Jano.

At Jano the Palæozoic coal is represented by isolated plants converted into anthracite; it is the only locality on the Italian continent where Carboniferous

fossils have been found; but Miocene lignites are abundant in Italy. At Sarzanello in Piedmont, six and a half feet of Miocene coal occurs. This is used in the Sardinian steam-navy. At Castiani, in the Maremme, good lignite, three feet four inches thick, is worked; and at Monte Bamboli, also in Tuscany, one bed four feet two inches, and another two feet thick, have long been in use. —[Abstract of paper by W. P. Jervis, Esq.].

REVIEWS.

On the Origin of Species by Means of Natural Selection; or the Preservation of Favoured Species in the Struggle for Life. By CHARLES DARWIN, M.A. London: John Murray. 1860.

We could scarcely let this year pass away without some notice of a book which at least will make 1860 remarkable in the annals of natural history science. Whatever opinion may be entertained of the speculations on the origin of species sketched out by Mr. Darwin in his introductory work to the fuller and more explicit one he announces for some future day, there is no doubt that in its entirety his theory is one which for many years to come must receive the earnest attention of the scientific world; for whether the law of the necessity of organic variation and development as dependant on external circumstances attendant on the general "struggle for life" be universal in application or not, Mr. Darwin has at any rate opened out a new vein of reflection and investigation which must be followed out until the new theory be either disproved or proved from its first causes to its final results.

Nor must we be prevented from the true examination of its value and merit by any previous prejudices, nor deterred by the objections and abuse of those who are ever ready to attack new opinions on the old and ridiculous grounds of a real or pretended dread of an antagonism to Holy Scripture, as if the Word was not based on the sure foundations of truth. "I must express my detestation of the theory," says one opponent, "because of its unflinching materialism; because it denotes the demoralized understandings of its advocates. Look, too, at their credulity. Why Darwin actually believes that a white bear, by being confined to the slops of the Polar Sea might be turned into a whale; that a lemur might be turned into a bat; that a three-toed tapir might be the great-grandfather of a horse; or the progeny of an ass may have gone back to a buffalo." Such, however, are mere verbosities, baseless assertions, unwarranted attributions of irreligion and gross ironical misrepresentations of an author's writings, too transparent not to be seen through by the well-versed student of Nature. There is, however, a speciousness of appearance in the positiveness of diction of this style of attack which misleads the unreflecting as the flame allures unwary moths, and which often causes such inflated pomposities to be mistaken for acknowledged facts. Time was, and not so long since, either, when fossils were enigmas even to the learned; when thoughtful and sapient men discussed with heat of temper and with angry tones whether such organic remains of past creations embedded in the soil were

really shells, and bones, and plants, or whether they were plastic forms modelled in the dark recesses of the ground. Even now a-days some literary adventurers and crack-brained sages—and we are sorry to say, some men, too, of better note but mistaken views—now and then attempt to palm off this long ago exploded whim under a specious guise upon an intelligent world. The danger from such productions is small, and few indeed of those worth caring for would think a fossil bone or shell aught else than the treasured fragment of some ancient living being.

More dangerous, however, are the wilful pervertors who argue with a specious show of knowledge; and such detractors Darwin's theory, like every other, is sure to bring forward against itself. "Species have been constant," says one, "ever since they first existed; change the conditions, and the old species would disappear. New species would come in and flourish. But how? by what causation? By *creation*. What is meant by creation? The operation of a power quite beyond the power of a pigeon-fancier, a cross-breeder, or a hybridizer, in which one can believe by the legitimate conclusion of sound reason drawn from the laws and harmonies of nature, and, believing, can have no difficulty in the repetition of new species."

Dickens, in one of his novels, very shrewdly remarks that the advice given to street-boys about to fight "to go in and win" is very excellent if they only knew how to follow it; and when one naturally asks how new species which geology shows us appearing from time to time *first* began, the answer, by *creation* is as easy to give and about as useless as the advice offered to the street-boys. It is, after all, a mere assertion, an evasion of the question, a cloak for ignorance. We see different races from time to time leaving their relics entombed in the solid rocks of the earth, we see the remains, however, only of the *perished* race; we have no proof, no trace, no evidence whatever in those great entombments of the origin or *first* appearance of the *progenitors* of those races. Those races might have sprung from single pairs, or the primitive individuals might have been *created* in hundreds. Few, we think, would incline to the opinion of the direct creation of hundreds of the like animals or plants at one time; but if, on the other hand, we incline to the *direct creation* of a single pair, we must admit that that pair must have been created ages before its race could be useful or necessary on the face of the earth; must have been created in fact in advance of those changes of physical conditions of our planet, which all admit to have been brought about in the lapse of time by natural operations, in order to provide for the necessary propagation of their descendants in sufficient numbers at the period when they should *usefully* abound. We should incline to think that a theory which proposed to view the development of the required races or species as concurrent with the physical changes rendering necessary their presence,—and as consequently necessarily developed by natural laws, like we see everywhere else around us so wisely and immutably preordained, apparently from the beginning of all things, by the Almighty Designer, —would be preferable to the idea of direct creations, and affording a more reasonable reply than the mere assertions of the miraculous agency with which our query is so commonly met.

But "the assumption of the *direct creation* of species is an hypothesis," says another, "which does not suspend or interrupt any established law of nature. It does not suppose the introduction of new phenomena unaccounted for by the operation of any known law; and it appears to be a power *above* established laws, and yet acting in conformity with them." It may be due to the astuteness of our intellect, but we cannot see how a power can be *above* and not be necessarily *antagonistic* to established laws, and consequently how it can be possible for such a power to be in conformity with such established laws.

"The pretended physic and philosophy of modern days," says a third,

"strips man of all his moral attributes, and holds as of no account his origin and place in the created world. A cold atheistical materialism pervades the sentiments of modern philosophy. The new doctrine is untrue and mischievous. It is opposed to the obvious course of nature, and the very opposite of inductive truth."

Why should it be considered atheistical to believe the laws of the Great Perfection to be *perfect*. The inscrutable Eternal cannot err; why then should His laws be so defective and imperfect as to require repeated efforts of creative energy? Is this world like an old watch so much out of order as to require continual oilings and repeated repairs? Why, too, should it be objectionable to consider the laws He has given to nature as worthily and incessantly subservient to His will? Or why should it be thought irreligious to believe the Maker of all things in His *first* designs should have foreseen the necessity of future modifications to future altered conditions, and have provided accordingly in His *first type-plans* for their future illimitable adaptations to the ever-changing scenes presented in the progress of our earth's ever-altering conditions? Why, indeed, may we not look around us and believe in the universal bowing of all nature hourly, daily, unceasingly to the unerring laws and sustaining power of God? Why should we not see in every change His presence and His will? Why should the high position of man be brought in on all occasions in our natural history researches when we do not at present know of any link which binds him to the brute creation?

If these remarks on our part seem strong, let it however be known that we are not professedly defending Mr. Darwin's doctrines, but attempting to pourtray as forcibly as we can the unjustness and uncharitableness of such attacks upon a new and well-studied theory. Let a new doctrine be always well and impartially examined, and justly accepted or rejected according to our honest opinions of its merits or failings. Mr. Darwin's theory briefly resolves itself into this.

First.—There is a natural struggle for existence.—"Look," he says, "at a plant in the midst of its range; why does it not double or quadruple its numbers? We know that it can perfectly well withstand a little more heat or cold, dampness or dryness, for else it ranges into slightly hotter or colder, damper or drier districts. In this case we can clearly see that if we wished in imagination to give the plant the power of increasing its number, we should give it some advantage over its competitors, or over the animals which preyed on it. On the confines of its geographical range, a change of constitution with respect to climate would clearly be an advantage to the plant: but we have reason to believe that only a few plants or animals range so far that they are destroyed by the rigour of the climate alone. Not until we reach the extreme confines of life in the Arctic regions or on the borders of an utter desert will competition cease. The land may be extremely cold or dry, yet there will be competition between some species, or between the individuals of the same species, for the warmest or dampest spots. Hence, also, we can see that when a plant or animal is placed in a new country, among new competitors, though the climate may be exactly the same as in its former home, yet the conditions of its life will gradually be changed in an essential manner. If we wished to increase its average numbers in its new home, we should have to modify it in a different way to what we should have done in its native country; for we should have to give it some advantage over a different set of competitors or enemies. It is good thus to try in our imagination to give any form some advantage over another. Probably in no single instance should we know what to do so as to succeed. It will convince us of our ignorance on the mutual relations of all organic beings; a conviction as necessary as it seems difficult to acquire. All that we can do is to keep steadily in mind that each organic being is striving to increase at a geometrical ratio; that at some period of its life, during some

season of the year, during each generation or at intervals it has to struggle for life, and to suffer great destruction. When we reflect on this struggle we may console ourselves with the full belief, that the war of nature is not incessant—that no fear is felt—that death is generally prompt,—and that the vigorous, the healthy and the happy, survive and multiply.

Secondly,—There is in nature a principle of natural selection.—"How will the struggle for existence," says Mr. Darwin, "discussed too briefly in the last chapter, act with regard to variation? Can the principles of selection, which we have seen so potent in the hands of man, apply in nature? I think that we shall see that it can most effectually. Let it be borne in mind in what endless number of strange peculiarities our domestic productions, and in a lesser degree, those under nature vary; and how strong the hereditary tendency is. Under domestication, it may be truly said that the whole organization becomes in some degree plastic. Let it be borne in mind how infinitely complex and close-fitting are the mutual relations of all organic beings to each other and to their physical conditions of life. Can it, then, be thought improbable, seeing that variations useful to man have undoubtedly occurred that other variations useful in some way to each being in the great and complex battle of life should sometimes occur in the course of thousands of generations? If such do occur, can we doubt (remembering that many more individuals are born than can possibly survive), that individuals having advantages however slight, over others, would have the best chance of surviving and of procreating their kind? On the other hand we may feel sure that any variation in the least degree injurious would be rigidly destroyed. This preservation of favourable variations and the rejection of injurious variations I call natural selection. Variations neither useful nor injurious would not be affected by natural selection and would be left a fluctuating element, as perhaps we see in the species called polymorphic. We shall best understand the probable course of natural selection by taking the case of a country undergoing some physical change, for instance, of climate. The proportional numbers of its inhabitants would almost immediately undergo a change, and some species might become extinct. We may conclude from what we have seen of the intimate and complex manner in which the inhabitants of each country are bound together, that any change in the numerical proportions of some of the inhabitants, independently of the change of climate itself, would seriously affect the others. If the country were open at its borders, new forms would certainly immigrate, and this also would seriously disturb the relations of some of the former inhabitants. Let it be remembered how powerful the influence of a single introduced tree or mammal has been shewn to be. But in the case of an island, or of a country partly surrounded by barriers, into which new and better adapted forms could not freely enter, we should then have places in the economy of nature which would decidedly be better filled up, if some of the original inhabitants were in some manner modified; and had the area been open to immigration, these same places would have been seized on by intruders. In such case, every slight modification, which, in the course of ages chanced to arise, and which in any way favoured the individuals of any species, by better adapting them to their altered conditions, would tend to be preserved, and natural selection would thus have free scope for the work of improvement. We have reason to believe, that a change in the conditions of life by specially acting on the reproductive system, causes or increases variability; and in the foregoing case the conditions of life are supposed to have undergone a change and this would manifestly be favourable to natural selection, by giving a better chance of profitable variations occurring, and unless profitable variations do occur, natural selection can do nothing. Not that, as I believe, any extreme amount of variability is necessary; as man can certainly produce great results by adding up in any given direction mere individual differences—so could

nature, but far more easily, from having incomparably longer time at her disposal. Nor do I believe that any great physical change, as of climate or of any unusual degree of isolation to check immigration, is actually necessary to produce new and unoccupied places for natural selection to fill up by modifying and improving some of the varying inhabitants. For as all the inhabitants of each country are struggling together with nicely balanced forces, extremely slight modifications in the structure and habits of one inhabitant would often give it an advantage over others; and still further modifications of the same kind would often still further increase the advantage. No country can be named in which all the natural inhabitants are now so perfectly adapted to each other, and to the physical conditions under which they live that none of them could any how be improved; for in all countries the natives have been so far conquered by naturalized productions, that they have allowed foreigners to take firm possession of the land. And as foreigners have thus everywhere beaten some of the natives, we may safely conclude that the natives might have been modified with some advantage, so as to have better resisted such intruders. As man can produce, and certainly has produced, a great result by his methodical and unconscious means of selection, what may not nature effect? Man can act only on external and visible characters; nature cares nothing for appearances, except in so far as they are useful to any being. She can act on every internal organ—on every shade of constitutional difference—on the whole machinery of life. Man selects only for his own good; Nature only for that of the being which she tends. Every selected character is fully exercised by her: and the being placed under well-suited conditions of life. Man keeps the natives of many climates in the same country; he seldom exercises each selected character in some peculiar and fitting manner; he feeds a long- and short-backed pigeon on the same food; he does not exercise a long-backed, or a long-legged quadruped in any peculiar manner; he exposes sheep with long- and short-wool to the same climate. He does not allow the most vigorous males to struggle for the females. He does not destroy all inferior animals, but protects during each varying season, as far as lies in his power all his productions. He often begins his selection with some half-monstrous form; or at least by some modification prominent enough to catch his eye, or to be plain and useful to him. Under nature the slightest difference of structure, or constitution, may well turn the nicely-balanced scale in the struggle for life, and so be preserved. How fleeting are the wishes and efforts of man! how short his time! and, consequently, how poor his products will be compared with those accumulated by nature during whole geological periods! Can we wonder, then, that nature's productions should be far "truer" in character than man's productions—that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship? It may be metaphorically said that natural selection is daily, hourly scrutinizing throughout the world every variation, even the slightest; rejecting that which is bad, preserving that which is good; silently and invisibly working whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life. We see nothing of these slow changes in progress until the hand of time has marked the lapse of ages, and then so imperfect is our view into long past geological ages, that we only see forms of life are now different from what they formerly were. * * * Slow though the process of selection may be, if feeble man can do much by his powers of artificial selection, I can see no limit to the amount of change, to the beauty and infinite complexity of the co-adaptations between all organic beings, one with another, and with their physical conditions of life, which may be effected in the long course of time by nature's power of selection."

The evident modifications of primitive type-plans, which indisputedly we see

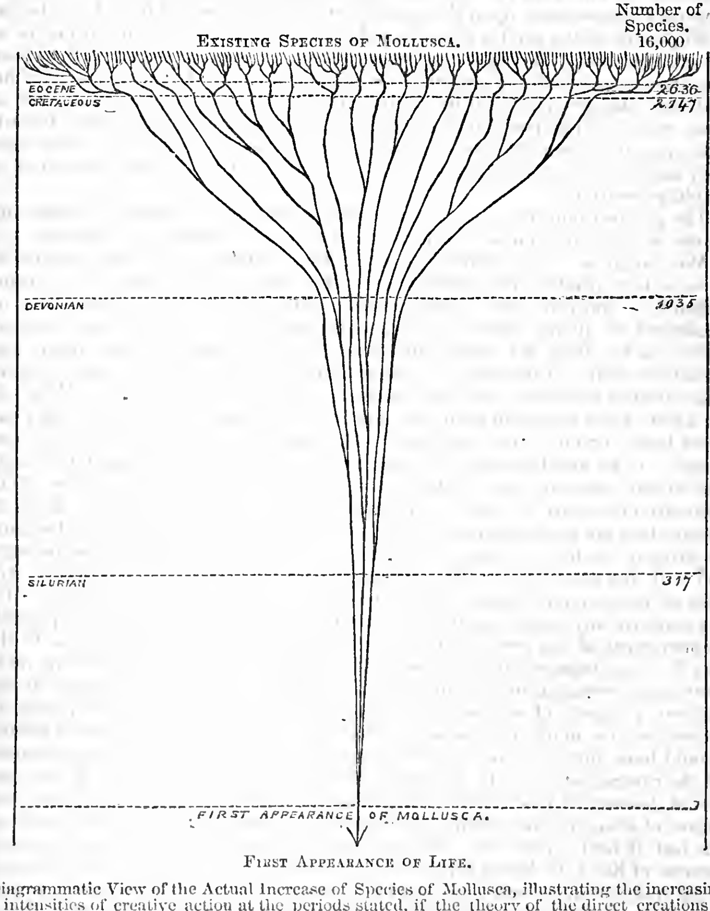
in past and present forms of life, are undoubtedly the strongest arguments in favour of Darwin's theory of progressive development by natural selection. But as geology alone must be the sole source of knowledge for testing or learning the effects of great periods of time in the gradual transmutation of species, so will our efforts be resultant of efficient proof only in proportion to the perfection or imperfection of the geological record. This record Darwin justly says *is* defective. No doubt, it is; no doubt there are great gaps in the earth's past history of which no trace remains—and many, and far more numerous gaps which scientific investigations have not yet filled up. Still, we may hope to find, and by patience and research no doubt we ultimately shall mark out, the great points in the picture around which the details may reliably be filled in by correctly drawn inferences. If we tabulate the number of known species of any particular class of animals or plants, we find the numbers invariably in the aggregate ranging higher until we attain a maximum in the present creation, notwithstanding there are occasional deficiencies of individual genera between certain geological formations which shows that we have not yet a perfect knowledge of all the forms living during those eras in which such deficiencies occur. Such results, however, are important in their bearing on the doctrine of the natural development of species. Taking for example the totals of known mollusca, we commence in the Silurian period with 317, and close in the recent with 16,000. It follows, then, that if in the pre-Silurian age life began on our planet with the same number of definite type-plans, such as the globular, the radiate, soft-bodied, the vertebrate, &c., which we see so prominently defined in the existing races; and taking the mollusca, for example, of that pre-Silurian period at unity, or as the first commencement of their special or direct creation; and regarding such special or direct creations as the miraculous interference of the Deity, then we have as a result an ever increasing ratio of miraculous inteferences, and we must also regard creative energy as sixteen thousand times more active in our time than in the pre-Silurian period. A condition of things few of us would be inclined to admit. On the other hand, this natural radiation of numbers—let us put it down by a diverging figure *(see woodcut, p. 470)* each line of which is representative of hundreds—is so representative of the natural radiation of life-forms by the splitting up of species by natural variations into new species,—one species first naturally divided into two species, these two into four, these four into eight, and so on, as would naturally result by the operation of natural laws carrying on gradually and incessantly the transmutation and subdivision of old into new species,—as to incline the mind at first sight to faith in the past operations of such natural laws in the production of the very numerous species now living around us.

The proportions of the level lines indicating the horizons of the various periods which the tree of increase of species does not cover, represents, of course, also the successively available spaces for the geographical spread of the species existant at those dates, for the earth's surface cannot exceed a definite limited area, the maximum of which may be considered to be represented by the border lines of the diagram.

The struggle for existence by the multiplied species seems thus to be continuously increased by a continuous and rapid decrease of available terrestrial space by the ever increasing sub-division and restriction of the geographical area.

It should also be borne in mind that the diagram shows only the increase of specific forms of one class of the animal kingdom—the mollusca. Taking these as having increased from unity to sixteen thousand; and taking the increase of all the other classes—the Radiata, Crustacea and Insects, the Vertebrates terrestrial, aërial, or aquatic, &c.,—as equal only to this sum in the aggregate of their similar specific increase, we have for the animal kingdom an assumed total of

thirty-two thousand. Taking the like sum as representative of a similar increase of species in the vegetable kingdom; and we obtain then, as a final result, the conclusion that the creative action as exerted in the direct creation of species, commencing in the pre-Silurian period at unity, has been successively and continuously intensified ever since, until now it has obtained an intensity sixty-four



First Appearance of Life.

Diagrammatic View of the Actual Increase of Species of Mollusca, illustrating the increasing intensities of creative action at the periods stated, if the theory of the direct creations of species be admitted.

[Each line of the Tree of Numerical Increase of Specific Forms represents 100 species.]

thousand times greater than when it commenced; or upwards of twenty-one thousand times greater than it was at that point in past time—the Silurian era —to which we can trace back the records of its action.

The radiata, the vertebrata, or any other class, exhibit the like results with the mollusca, confirming the impression of the prolificness of existing species as due to the natural sub-division by natural transmutating

operations during past ages of a fewer number of original forms. We cannot follow Mr, Darwin through all his arguments in support of his theory, nor do we always agree with his teachings, still so many important problems can be feasibly solved by the application of his doctrine, as go far to convince one that it has a really good foundationfor three great natural truths—the undoubted influence of the struggle for life; the necessitous interference of external physical circumstances upon the varieties and conditions of life and vegetation at all periods of the earth's history; and the existence, at least, of a principle of natural selection. We should on some points be inclined to go further than Mr. Darwin, especially in regard to the matter of time. Granting his position that the changes produced by natural selection *usually* require great ages of time, we are still disposed to consider that such changes might, under favourable or active circumstances be rapidly accomplished, and that in some cases they might even be brought about in the range of two or three or even of a single generation.

The greatest objection, it seems to us, which can be brought against the theory is its reliance on *natural* causes and *chance* in effecting the changes.

We should be more inclined to refer the modifications which species of of animals or plants have undergone to the direct will of God, for it seems difficult to conceive how a being totally ignorant of its own structure or conditions of living should so commence modifying its structure, form, or habits, as to adapt not itself, but successively its progeny to new forms and conditions of life. Take ourselves—some few who have undergone severe anatomical studies excepted—and how much do we know of our bodies? What do we know of the organs in their interiors? Do we know how often in a day our heart beats, or our lungs palpitate? How many ounces of blood run in our veins? If we are ill can we tell what organ is affected? or diseased internally can we say where or why? Do we of ourselves, untaught even, know either the existence or use of one of our unseen and not external organs? Even of those which are visible what do we know? can we tell why the will causes the hand to write, or the feet to walk? Or what is the means of communication between our will and our limbs? Did our progenitors, however remote, conceive the idea of nails to our fingers, eyelids to our eyes, or lashes for our eyelids? Do we conceive any improvement in our offspring? Could we suggest any possible improvement of our present structure? Could we add one beautiful line to the face? or one more efficiently constructed limb? Could we suggest any more convenient arrangement, or disposition of our parts? And if *we*, standing at the highest pinnacle of knowledge, cannot suggest a sportive variety, even, of ourselves, how much less can we consider that mere brutes, or insensate plants, should have any innate power of themselves to cause the slightest improvement of their organization? If we could not suggest one improvement of our condition, how much less can we believe that the alpine partridge effected his own power of changing the colour of its feathers, or the insect assume the colour of the leaf it feeds upon; and still less can we conceive how the peach could assume of itself its downy surface, or the plum its purple bloom. Such results if naturally produced can only emanate from divine laws. The beautiful perfection of our bodies—the wonderful adaptations in the forms of animals to render them efficient for their purposes of life seem so skilfully planned, that it is impossible to regard them as effects of chance, and not as inapproachably perfect designs. If we could accept the transmutation doctrines, we must concede the transmutatory laws as of pre-eminently divine origin and maintenance, purposely conceived to be ever forcibly acting in direct antagonism to the necessity of destruction and change, to which all nature seems subject. In this light we might accept it, and trace back the natural divergence of life-forms to the first vital force thrown off from the hand of the Creator, who threw off with an

eternal and ever enduring force the vast clouds of vapours that have in the roll of ages collapsed into the myriads of worlds and suns that swarm in the heavens above and around us—of which we can neither see the limits nor conceive the expanse—but which may yet be the smallest and least wonderful of all the myriads of world-clusters with which the same great Creator has star-dusted His course through the realms of boundless and interminable space.

Reynolds' Geological Atlas of Great Britain. London: James Reynolds, 174, Strand.

This is a series of thirty-three small quarto maps folded and bound into an ordinary octavo book—a very convenient and useful size. These maps are very neatly and cleanly executed; and on them the principal roads and railways, both those constructed and those constructing, are laid down, and the geological features intelligibly and neatly coloured in, but not always quite so carefully as to areas as ought to pass out to the world under the authority of Professor Morris, whose assistance the editor acknowledges. The maps, however, offering a really good foundation for every essential detail, there is no reason why, under the direction of so able a geologist, all such errors should not be instantly corrected before the issue is made to the public. For example, in our copy the district from Hythe to Folkestone is coloured in as Upper Greensand and Gault, instead of as Lower Greensand, as every geologist knows it is from the memorable paper of Dr. Fitton "On the Strata below the Chalk," and which work is quoted as one of the authorities on which the geological information of the present series is based. Again, the tongue of land outside the river Stour, in front of Sandwich, and between Deal and Pegwell Bay is coloured down as Chalk, while every antiquary, and we thought everybody else, knew that tract was open water to the old Roman port of Richborough, and formed the mouth of the estuary which, passing between the Isle of Thanet and the mainland, was up to medieval times, indeed, used as a passage by ships voyaging to London.

This map was sent to us in time for review last month; but Mr. Reynolds having found out some errors in his map of Scotland, requested us to withhold our criticism until that map had been amended, which has now been done. As far, however, as the execution of the maps, and the size, style, and small cost of the work are concerned, Mr. Reynolds has done well his duty as publisher; and if he will pass his maps under the careful inspection of his friend Professor Morris, we have no doubt that the atlas will be relieved of such slight blemishes as those which have caught our scrutinizing eye, and be justly entitled to a general favoritism with students and travellers, as well as for use in schools.

We sincerely wish success to all such efforts, but we are nevertheless bound to look for defects in all new publications of this class, as in their general accuracy consists their chief value; we desire at the same time to give honest criticisms, both for the guidance of those of our readers who rely on our judgment, and for the just encouragment of producers, an encouragment we are the more pleased to give when we see a desire manifested, as in the present case, to attain correctness, by retaining the services of gentlemen who, by their knowledge and talent, are able to secure it.

END OF VOL. III.

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